EXHIBIT 11

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

OPTIS WIRELESS TECHNOLOGY, LLC, OPTIS CELLULAR TECHNOLOGY, LLC, UNWIRED PLANET, LLC, UNWIRED PLANET INTERNATIONAL LIMITED, AND PANOPTIS PATENT MANAGEMENT, LLC, Plaintiffs, v. APPLE INC., Defendant.	Civil Action No. 2:19-CV-00066-JRG Jury Trial Demanded

DECLARATION OF MARK LANNING
PURSUANT TO PATENT LOCAL RULE 4-3(B)

U.S. PATENT NO. 8,019,332

TABLE OF CONTENTS

I, Mark Lanning, declare as follows:

1. I have been retained by counsel for Apple Inc. ("Apple") to provide opinions in this matter regarding U.S. Patent No. 8,019,332 (which I may refer to as the "'332 patent"). I submit this Declaration to explain how one of ordinary skill in the art would understand certain claim terms in dispute.

2. I am being compensated at my normal consulting rate of $550 per hour. My compensation does not depend on the outcome of this matter, and in no way affects the substance of my statements in this Declaration.

3. I have no financial interest in any party to this case.

4. In preparing this Declaration, I have considered the following materials:

- The '332 patent;
- The file history of '332 patent;
- The parties' proposed constructions;
- The evidence cited by the parties in their respective claim construction disclosures; and
- The evidence cited within this Declaration.

I. BACKGROUND AND QUALIFICATIONS

5. I am currently the President of three consulting companies: Telecom Architects, Inc., I.N. Solutions, Inc., and Reticle Consulting, LLC. All three companies provide professional consulting services and custom software development for one or more particular technical areas. Telecom Architects, Inc. was established in 1999 to provide specialized consulting services to fixed and wireless telecom service providers and their suppliers. I.N. Solutions (Intelligent Networking Solutions) was established in 1991 with an emphasis on applications design and

network architecture engineering for telephone-based switching and Advanced Intelligent Networking systems. Reticle Consulting was created in 2009 to provide specialized consulting services for forensic software analysis and software source code analysis.

6. I have over 40 years' experience in a wide variety of communication technologies including, but not limited to, paging systems and pager protocols, modems and modem protocols, circuit-switched and packet-switched networks, cellular networks and their components, advanced cellular network based services, Public Switched Telephone Network ("PSTN") networks, VoIP networks, Advanced services that use Intelligent Networking ("AIN") network elements, and various signaling protocols (e.g., Signaling System 7 ("SS7") and Integrated Digital Services Network ("ISDN")).

7. My communications experience began in 1976 while I was enlisted in the U.S. Army Signal Corps. Specifically, I worked in the U.S. Army Security Agency (ASA) where I was a member of a technical team responsible for upgrading worldwide voice and data communications used by the White House staff and other government agencies.

8. Beginning in 1984, I was a member of a team responsible for converting a PSTN switch into a cellular mobile switching center that Motorola and other companies used extensively in cellular networks located the U.S. and other countries. I have also been a member or manager of development teams that built cellular network elements and specialized cellular applications. These network element types include at least: base station; home location register; short and multimedia message centers; intelligent peripherals; personal number plans; and pre-paid billing systems. These applications include, but are not limited to, creating, processing and delivering Short Message Service (SMS) and Multimedia Message Service (MMS) messages in cellular networks and cellular phones.

9. Since 1991, I have been responsible for the design and implementation of multiple packet-switched networks and their required interfaces to different circuit-switched networks. Examples of these networks are British Telecom, Nextel, and Sprint.

10. Beginning in 1991, I was a consultant to Motorola on its SuperCell base station where I worked directly with the Motorola paging system design engineers to ensure the SuperCell base station could be used for both cellular and paging applications. As part of my consulting, I performed a detailed analysis of the downlink and uplink channel requirements used in 2G GSM and 2G IS-95 cellular systems.

11. I have detailed development experience for the majority of the network equipment and mobile phones (user equipment) that are used for 1G AMPS, 2G IS-95, 2G GSM, 3G CDMA-2000 and 3G UMTS cellular networks and have worked directly with multiple mobile phone suppliers to define the functionality required for multiple models of phones and resolve issues and problems that occurred.

12. I have also been responsible for the design and implementation of multiple packet-switched networks and their required interfaces to different circuit-switched networks. Examples of these networks are British Telecom, Nextel, and Sprint.

13. In addition to my experience listed above, for at least the past ten years, I have been updating my knowledge of the present-day 3G, 4G and 5G network standards and their associated equipment and protocols through my study of each new release of these standards, technical books and trade publications as well as my expert work in legal cases, which has involved evaluating the functionality of many different types of network equipment, mobile devices, baseband chipsets and thousands of cellular oriented patents.

14. I am a member of the Institute of Electrical and Electronics Engineers (IEEE), including the IEEE Standards Association. I am also a member of the Association for Computing Machinery (ACM). I was also a member of the American National Standards Institute (ANSI) T1 and T1X1 standard groups responsible for the definition and standardization of the Advanced Intelligent Network (AIN) and Signaling System 7 (SS7) protocol.

15. I received my Bachelor of Science degree in Computer Science from Southern Methodist University (SMU) in 1983. More details on my education, work experience and technical consulting experience, as well as a list of publications that I have authored or co-authored, and my testifying experience are contained in my curriculum vitae. A copy of my curriculum vitae (including a list of publications) is attached as Exhibit A.

II. LEGAL PRINCIPLES

16. I am not an attorney. For the purposes of this declaration, I have been informed about certain aspects of the law that are relevant to my opinions, as described below.

17. I have been informed and understand that the terms of a patent claim are generally given their ordinary and customary meaning. This is the meaning that the term would have to a person of ordinary skill in the art at the time of the alleged invention (the time at which the application for the patent was filed).

18. I have been informed and understand that although the parties may not agree on the priority date for the '332 patent, the earliest alleged priority date for the patent is March 7, 2008, which I understand the Plaintiff alleged in its contentions.

19. I have been informed and understand that a patent specification may reveal a special definition given to a claim term by the patentee that differs from the meaning it would otherwise possess. In such cases, the inventor's "lexicography" governs. In other cases, the specification may reveal an intentional disclaimer, or clear disavowal, of claim scope by the

inventor. In that instance as well, I have been informed and understand that the inventor has dictated the correct claim scope, and the inventor's intention, as expressed in the specification, governs.

20. I have been informed and understand that terms of a claim should be understood in the context of the claim as a whole. I also understand that the specification of the patent is relevant to the meaning of a claim term. I have been informed and understand that the claims must be read in light of the specification.

21. I have been informed and understand that the file history should also be considered when interpreting the meaning of the claims of a patent. The file history can contain evidence of how the U.S. Patent and Trademark Office ("PTO") and the applicant understood the patent and the meaning of the terms of the patent.

22. I have been informed and understand that the claim language, specification, and prosecution history are referred to as "intrinsic evidence." I also have been informed and understand that proceedings before the PTO regarding the issued patent such as *inter partes* reviews (IPRs) may also be considered intrinsic evidence.

23. I have been informed and understand that evidence from an expert in the field may also be relevant in the determination of how a person of ordinary skill in the art would understand the claims. I have been informed and understand that this evidence, which is referred to as a type of "extrinsic evidence," must be considered in the context of the intrinsic evidence and cannot be used to change the meaning of a claim term to be inconsistent with the intrinsic evidence.

24. I have been informed and understand that the terms in the claims of patents are required by statute to be definite. While terms do not need to be defined with mathematical

precision, I have been informed and understand that the terms of a claim must inform one of ordinary skill in the art about the scope of the terms and the scope of the alleged invention with reasonable certainty. I have been informed and understand that a term is indefinite if it does not provide one of ordinary skill in the art with reasonable certainty about the scope of the term. I further understand that the specification and prosecution history should be consulted to determine whether a claim term is definite because the specification and prosecution history can inform the meaning and scope of a term.

III. LEVEL OF ORDINARY SKILL IN THE ART

25. The ‘332 patent is directed to a method and apparatus for transmitting and receiving information in a mobile communication network through a physical downlink control channel.

26. In determining whom a person having ordinary skill in the art would be, I considered the ’332 patent, the types of problems encountered in mobile communications, the prior art solutions to those problems, the rate of innovation in mobile communications and related fields, the relative technical complexity of mobile communication networks, and the educational level of those who work in the field. I also understand that one of the plaintiffs’ experts in this case had previously opined that such a person would be “someone with an undergraduate degree in electrical engineering, computer science, or computer engineering, or a related field, and around two years of experience in the design, development, and/or testing of cellular networks or equivalent combination of education and experience.” *BlackBerry Corp., v. Optis Wireless Tech., LLC*, PTAB-IPR2017-00754, Ex. 1003 (Declaration of Paul Min, Ph.D.) at 11-12.

27. Based on these factors, and on my familiarity with the technology described in the patent, a person of ordinary skill in the art at the time of the alleged invention would have at least

an undergraduate degree in electrical engineering, computer science, or computer engineering, or a related field, and two years of experience in the design, development, and/or testing of cellular networks or equivalent combination of education and experience. This description is approximate, and a higher level of education or skill might make up for less experience, and vice-versa. I was as at least a person of ordinary skill in the art as of March 7, 2008.

IV. OVERVIEW OF THE '332 PATENT

A. Technology Background

28. The '332 patent states that it is directed to a method for "transmitting and receiving control information through a Physical Downlink Control Channel (PDCCH)." '332 patent at Abstract, 1:38-54. A version of that PDCCH channel was defined as part of the 3GPP LTE mobile phone system standard that was being developed prior to the filing of the '332 patent.[1] The 3GPP LTE standard addressed how cellular base stations could communicate with devices like cell phones and other cell-based devices. Those devices were (and are still) collectively referred to as "user equipments" or UEs.

29. In the LTE mobile phone system, each UE has one or more unique identification numbers. Those identifiers are used to identify the UE within the network and/or within the set of other UEs that may be using the same base station for communications. These identifiers are sometimes referred to as UE IDs. An example of a UE ID is an RNTI—a "Radio Network

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[1] Although Release 8 of the 3GPP standard that is referenced at 1:32-37 in the '332 patent was not "frozen" until late in 2008, earlier versions of the developing standard had been published before 2008. *See, e.g.*, https://www.etsi.org/technologies/mobile/4g

Temporary Identifier." Prior Art LTE Standard[2], Section 3, "Definitions, symbols and abbreviations."

30. As described above, the '332 patent states that it relates to the channels used in an LTE cellular network. '332 patent at 1:33-37. LTE is the abbreviation for Long Term Evolution, which means it is a 4G cellular standard that was not completely developed from the start as a new system. Instead, LTE has evolved from the 3G UMTS (Universal Mobile Terrestrial System) standard and the 2G GSM standard where many of the concepts defined in these standards have been retained and changes were made only to the parts of the standard necessary to meet the new objectives of LTE. All three of these standards are maintained and revised by the 3rd Generation Partnership Project (3GPP) group.

31. As described on the 3GPP standards website, LTE (both radio and core network evolution) is now on the market. Release 8 was frozen in December 2008 and this has been the basis for the first wave of LTE equipment.

32. As shown by the diagram below, GSM was developed to mainly carry voice calls in a circuit switched manner (blue in Illustration 1, below), with data services only possible over a circuit switched modem connection at very low data rates. The first step towards an IP based packet switched (green in Illustration 1, below) solution was taken with the evolution of GSM to GPRS, using the same air interface and access method, TDMA (Time Division Multiple Access).

33. To reach higher data rates in 3G UMTS a new access technology called WCDMA (Wideband Code Division Multiple Access) was developed. The access network in UMTS

[2] I will refer generally to the ETSI TS 136 211 LTE standard. Unless otherwise noted, each such reference includes those versions of the standard that were available prior to the alleged March 2008 priority date for the '332 patent. For that reason, I will refer to the LTE standard as the "Prior Art LTE Standard."

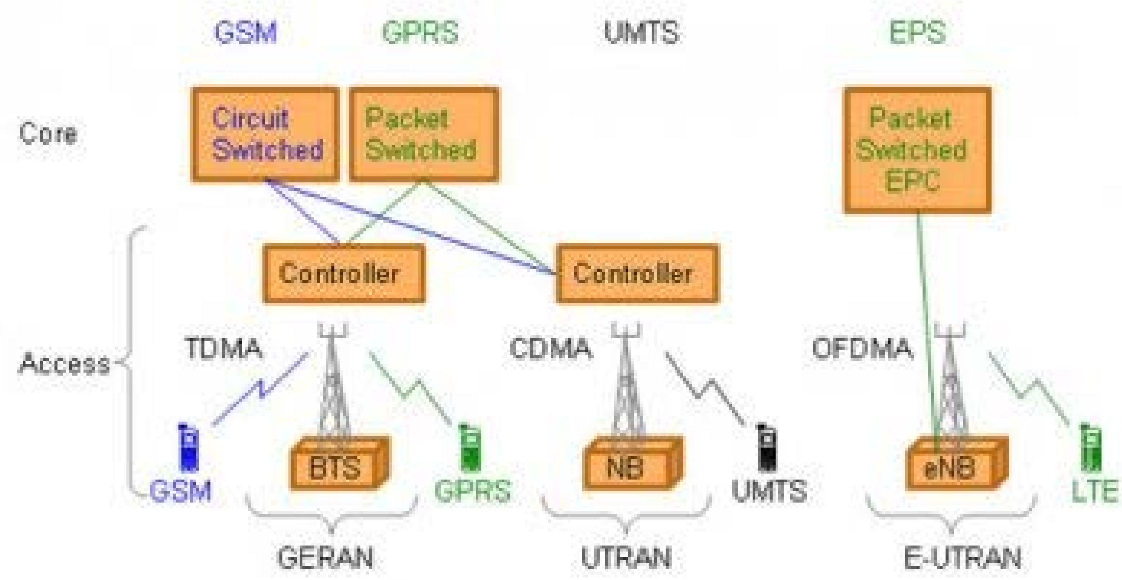
emulates a circuit switched connection for real time services and a packet switched connection for datacom services (black in Illustration 1, below). In UMTS the IP address is allocated to the UE when a datacom service is established and released when the service is released. Incoming datacom services therefore still rely upon the circuit switched core for paging.

34. LTE's Evolved Packet System (EPS) is purely IP based. Both real time services and datacom services are carried by the IP protocol. The IP address is allocated when the mobile is switched on and released when switched off.

35. The highest theoretical LTE peak data rates are 75 Mbps in the uplink and can be as high as 300 Mbps in the downlink.

36. A base station in the LTE standard is referred to as eNodeB (eNB). An eNodeB uses multiple radio channels to communicate with many mobile phones referred to as UEs. The channels transmitted to the UE from the eNodeB are referred to as downlink channels and the channels transmitted from the UE to the eNodeB are referred to as uplink channels. A UE typically does not send or receive data to or from the eNodeB at random, instead, the UE needs to receive allocations from the eNodeB for when it can expect to receive data and when it can send data as described in detail below.

Illustration 1



https://www.3gpp.org/technologies/keywords-acronyms/98-lte

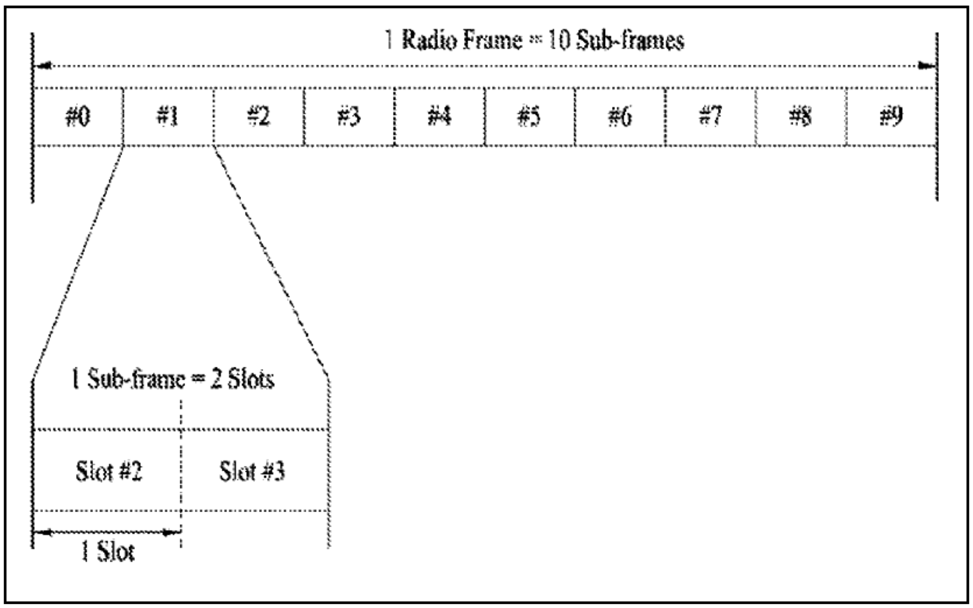
37. The prior-art LTE standard defined various uplink and downlink channels. The patent describes one such downlink channel—the PDCCH (Physical Downlink Control CHannel) —and notes that "[M]ultiple UEs [user equipment] can receive control information through a PDCCH transmitted from the base station." '332 patent at 1:56-58. The patent states:

> Among the various channels, the PDCCH serves to transmit scheduling allocation control information and other control information. In a cellular communication system in which one base station (or Node-B) controls a plurality of User Equipments (UEs) or (mobile stations), multiple UEs can receive control information through a PDCCH transmitted from the base station. Here, since there is a limit to the number of PDCCHs that the base station can transmit at once, the base station does not previously allocate different PDCCHs to each UE but transmits control information through an arbitrary PDCCH to an arbitrary UE at each time. Thus, the UE determines whether or not control information received through the PDCCH belongs to the UE based on a UE identifier included in the PDCCH. At each time, the UE performs decoding on each of a plurality of PDCCHs (for a plurality of possible PDCCH formats) and receives, when it is determined that the PDCCH corresponds to the UE, control information included in the PDCCH and operates according to the control information.

'332 patent at 1:52-2:3.

38. An LTE radio frame can be considered a unit of time (generally 10ms) into which downlink and uplink transmissions are organized. ’332 Patent at 7:45-50; Prior Art LTE Standard at Section 4. These radio frames generally occur continually, one-after-the-other, in an LTE system.

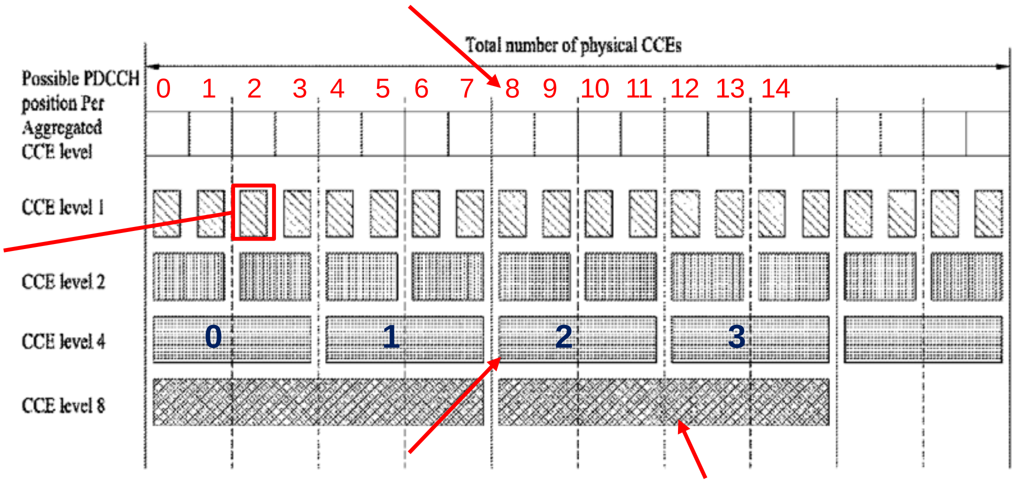
39. According to Fig. 7 of the ’332 Patent below, each 10ms radio frame is further divided up evenly into 10 sub-frames (numbered 0-9). As also shown in Fig. 7 below, each sub-frame is further evenly divided into 2 slots. Fig. 7 has highlighted slots 2 and 3 that are contained in sub-frame number 1.



’332 patent Fig. 7.

40. In the Annotated ’332 patent Figure 2 (referred to herein as “Annotated Figure 2”), shown in Illustration 2, below, the numbers 0-19 on the top row are for the 20 possible CCE positions:

Illustration 2



’332 patent at Fig. 2 (annotations added).

41. The eNodeB (base station) may communicate with one or more UEs using data packets that are referred to by the LTE standard as Downlink Control Information (DCI) messages. These DCI messages can be of different sizes depending on the amount of information that is to be transferred to the UE and the LTE standard defines 4 different message formats. For example, the DCI messages that are used to specify to the UE its uplink data allocation assignments for sending data to the eNodeB are referred to as DCI format 0 messages.

42. Some of the DCI messages may not be not transmitted to a UE in the smallest data group because they are too long. Instead, these longer DCI messages are divided and sent in chunks referred to as Control Channel Elements (CCEs). The number of CCEs required for each message, which can be 1, 2, 4 and 8, is based on the format chosen by the eNodeB (determined by the total number of bits required for the DCI message and other factors). Each CCE contains smaller groups of data referred to as Resource Elements. Each CCE contains 36 Resource Elements. When more than one CCE is used for a DCI message, the process of connecting them together is referred to as CCE aggregation. ’332 patent at 4:46-54.

43. The ’332 Patent describes how the Resource Elements contained in a CCE and CCE aggregation are used to carry DCI messages that can be transmitted on one or more PDCCH channels as:

> A PDCCH can be transmitted through a CCE aggregation including one or more Control Channel Elements (CCEs). In addition, a plurality of PDCCHs can be transmitted in one subframe. Here, the term “CCE” refers to a resource unit for transmission of control information, which is a unit corresponding to a specific number of resource elements in the resource space.

’332 patent at 4:46-54.

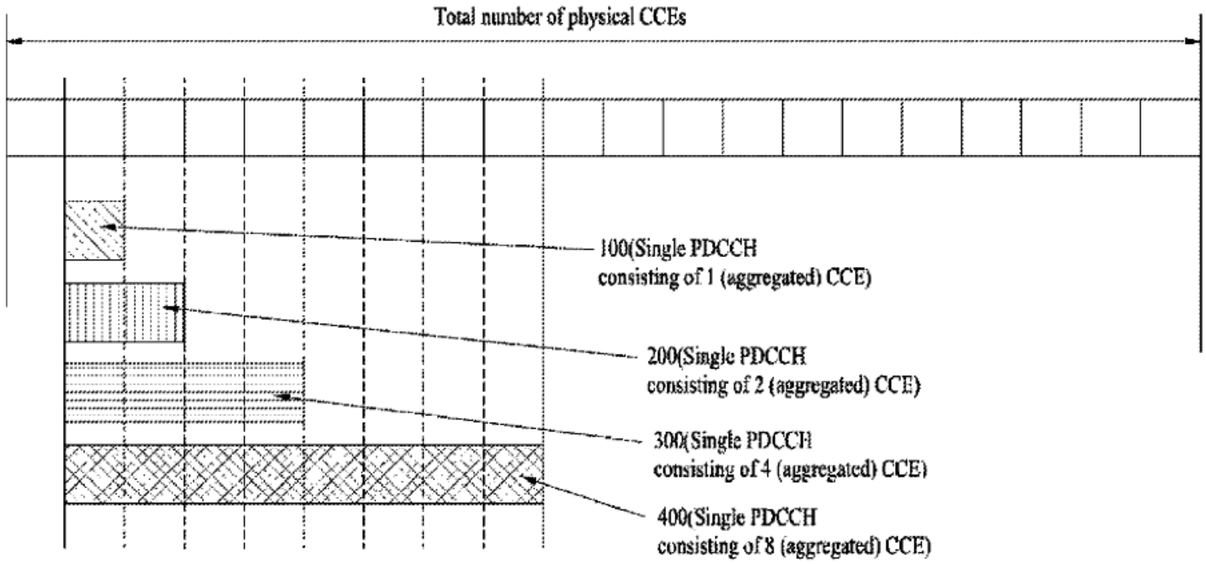
44. Thus, a subframe for each PDCCH channel (such as shown in Illustration 2, above) can have many CCEs and the way the CCEs are aggregated together, if at all, is determined by the eNodeB and based on the format of the DCI message being transmitted to the UE.

45. Specifically, according to the ’332 patent and as shown in Annotated Figure 2 at Illustration 2, above, the ’332 patent discloses that PDCCHs[3] can be comprised of a group of single CCEs or aggregations of multiple CCEs. The number of individual CCEs that can be aggregated together when sending a DCI message depends on the PDCCH format, where the format allows for CCE aggregation levels of 1, 2, 4, or 8 CCEs. *See* ’332 patent at 4:56-67, Table 1. The patent refers to the aggregation level with the shorthand variable “L”, where L can be 1, 2, 4, or 8. Although these aggregated blocks of data are comprised of 2-8 temporal spaces and positions that the individual ‘L’ CCEs comprise, the CCE aggregation can still be considered a single, unitary CCE that is carrying the whole DCI message. This is true even though individual CCEs may still be referred to individually to (for example) identify their location within the subframe.

[3] The ’332 patent refers to the DCI message as a PDCCH transmission.

46. The ’332 patent Figure 1 included below in Illustration 3 shows various examples of PDCCHs at the four different aggregation levels, where each aggregated CCE starts at the same position. For example, Figure 1 shows:

Illustration 3



’332 patent at Fig. 1.

47. Only one aggregation level is used for any particular subframe, so the set of CCEs in a single subframe would look like only one of the four levels shown in Figure 2 (Illustration 2, above).

48. A specific CCE aggregation can be identified within a subframe in at least two ways. First, as shown in Annotated Figure 2 for level 4 (Illustration 2, above), each CCE aggregation can be given an ordinal index number such as the 0, 1, 2, 3, and 4 numbers annotated in blue. The patent refers to this type of numbering as “an index assigned to each CCE aggregation.” ’332 patent at 9:17-23. I will refer to these types of numbers as part of a “CCE-aggregation-based” numbering.

49. As an example of "CCE-aggregation-based" numbering for aggregation level L=2, the patent describes assigning an index on a "2-CCE basis." '332 patent at 9:17-23. As another example, the blue CCE-aggregation-based number "2" refers to the third 4-CCE-wide aggregation in the level 4 format. Because these numbers start at 0, the particular number is 2, even though it identifies the third CCE aggregation from the left.

50. Alternatively, using the second method, PDCCHs and the CCEs on which they are based can be identified in a subframe by the CCE position within the subframe at which the PDCCH starts. I will refer to this unit of identification as "CCE-based" to distinguish it from "CCE-aggregation-based" identification. For example, as shown in Annotated Figure 2, Illustration 2, above, the same level 4 CCE aggregation identified by the blue "2" in units of "CCE-aggregation-based" identification, can also be identified in units of CCE-based numbering as starting at the 9th CCE position (0-based position number/index 8). The relationship between these values is that "8" is the CCE within the subframe at which the CCE aggregation numbered "2" begins.

51. As shown in the examples just given, a CCE-aggregation-based index can be converted to a CCE-based index by simply multiplying the former by the level of aggregation. In equation form, CCE Units = L x CCE-aggregation Units. As I explain below, some of the equations in the '332 patent produce CCE-aggregation-based indexes, and other equations produce CCE-based indexes.

B. The Alleged Problem

52. The patent states that in 3GPP LTE, the base station broadcasts all PDCCHs to all UEs. *See* '332 patent at 1:52-2:3. Thus, each UE that receives data from the base station will receive all the transmitted PDCCHs regardless of whether those PDCCHs are directed at the particular UE. *Id.* According to the '332 patent, to prevent a PDCCH (DCI message) from being

used by the wrong UE, each PDCCH is encoded in a manner that is specific to the UE to which it is directed. If any other UE decodes the information, its UE identification will not match.

53. Prior to receiving the PDCCHs for each subframe, each UE will not know which (or even, if any) of the PDCCHs is destined for that particular UE. The UE also does not know which aggregation level is in use for the PDCCHs it receives. Thus, according to the patent, the UE must try to decode each potential PDCCH for each aggregation level. *See* ’332 patent at 1:63-2:3. This means that the CCE at (for example) CCE-based index 0 could comprise a single CCE, or else could be just the first half, quarter or eighth of a larger CCE aggregation of level L = 2, 4, or 8. *See* ’332 patent at Fig. 1.

54. Because a UE does not know in advance when a PDCCH has been transmitted to the UE, the ’332 patent states that the UE must determine whether it has received a PDCCH destined for it by decoding each PDCCH candidate in a “PDCCH region” (e.g., the subframe) to determine if any of the PDCCHs includes the UE’s identifier. ’332 patent at 1:62-2:3.

55. The ’332 patent claims that “the number of combinations of PDCCH regions for transmission of control information may be great. Excessive UE processing performance may be required for the UE to decode all these PDCCH regions. Accordingly, there is a need to limit PDCCH regions to be decoded by each UE to reduce the number of times the UE performs decoding and thus to reduce power consumption of the UE.” ‘332 patent at 2:4-10. The patent also states that “[a]n object of the present invention devised to solve the problem lies in providing a technology for efficiently transmitting and receiving control information through a Physical Downlink Control Channel (PDCCH). Another object of the present invention devised to solve the problem lies in providing a technology for efficiently setting a different start position

of a search space for each UE in order to transmit and receive control information to and from each UE through a different search space." '332 patent at 2:14-22.

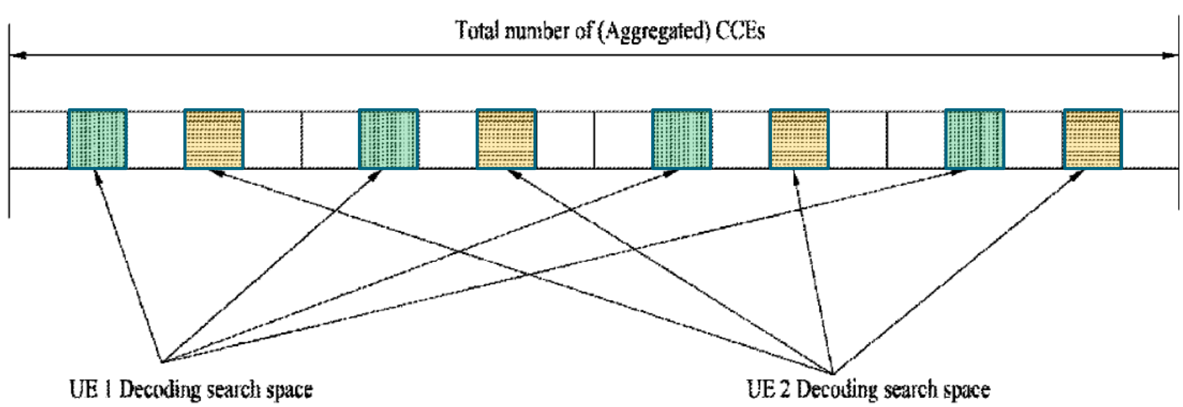
C. The Alleged Solution

56. The patent claims to address the alleged problems by "providing a technology for efficiently setting a different start position of a search space for each UE in order to transmit and receive control information to and from each UE through a different search space." '332 patent at 2:19-22; *see also id.*, 3:37-40 (the "Summary of the Invention" stating that "[s]pecifically, a different start position of a search space can be set for each UE so that control information can be transmitted and received to and from each UE through a different search space"). The patent discusses generally the "search space" or "search region" with reference to Figure 3, stating that:

> a region that each UE needs to attempt to decode to receive a PDCCH is referred to as a "search space". In the example of FIG. 3, both a UE 1 and a UE 2 have a CCE aggregation level 1 but have different decoding search spaces. That is, the base station can simultaneously transmit a PDCCH [DCI message] to the UE1 and the UE2 since the decoding search spaces do not overlap as shown in FIG. 3.

'332 patent at 5:51-57.

<u>Illustration 4</u>



'332 patent at Fig. 3 (annotated).

57. As shown in Illustration 4, above, one potential search space comprises the green-shaded CCEs, and a second search space comprises the yellow-shaded space. While the above

figure generally shows regions of the search spaces as non-contiguous, the patent's claims each recite search spaces that are made up of contiguous CCEs.

58. The specification distinguishes between the following two types of embodiments for determining the start positions of the search regions:

1. Embodiments that provide a start position in units of a CCE aggregation (e.g., for L=8, the start position of the first 8-CCE aggregation would be index '0', and the second 8-CCE aggregation, the start position would be '1'), and

2. embodiments that provide a start position in units of CCEs (e.g., for L=8, the unit CCE positions would be 0, 7, 15, etc.)

59. These two types of embodiments correspond to the two ways of identifying PDCCH (DCI message) locations as I discussed earlier.

D. The Asserted Claims

60. I understand that plaintiffs have asserted that Apple infringes claims 1-10 of the '332 patent, of which claims 1 and 6 are independent. I may refer to claims 1-10 as the Asserted Claims. Claim 1 recites the following:

> 1. A method for decoding control information by a User Equipment (UE), the method comprising:
>
> receiving a Physical Downlink Control Channel (PDCCH) from a base station at subframe k; and
>
> decoding a set of PDCCH candidates within a search space of the PDCCH at the subframe k, wherein each of the set of PDCCH candidates comprises 'L' control channel elements (CCEs),
>
> wherein the 'L' CCEs corresponding to a specific PDCCH candidate among the set of PDCCH candidates of the search space at the subframe k are contiguously located from a position given by using a variable of Y_k for the subframe k and a modulo 'C' operation, wherein 'C' is determined as 'floor(N/L)', wherein 'N' represents a total number of CCEs in the subframe k, and
>
> wherein Y_k is defined by:
>
> $Y_k = (A^*Y_{k-1}) \bmod D$,

wherein A, and D are predetermined constant values.

61. Claim 6 recites the following:

6. A user equipment (UE) for decoding control information, the UE comprising:

a receiver for receiving a Physical Downlink Control Channel (PDCCH) from a base station at subframe k; and

a decoder for decoding a set of PDCCH candidates within a search space of the PDCCH at the subframe k, wherein each of the set of PDCCH candidates comprises 'L' control channel elements (CCEs),

wherein the 'L' CCEs corresponding to a specific PDCCH candidate among the set of PDCCH candidates of the search space at the subframe k are contiguously located from a position given by using a variable of Y_k for the subframe k and a modulo 'C' operation, wherein 'C' is determined as 'floor(N/L)', wherein 'N' represents a total number of CCEs in the subframe k, and

wherein Y_k is defined by:

$$Y_k = (A * Y_{k-1}) \bmod D,$$

wherein A, and D are predetermined constant values.

62. I note that these claims include the term "mod" such as in "mod 'C'" and "mod 'D'". The term "mod" is known as shorthand for the centuries-old mathematical operation "modulo," sometimes referred to as modulo division. Just like operations such as "+" (add), "-" (subtract), "*", "x" or "·" (all symbols for multiply), and "/" and "÷" (symbols for divide), the "mod" operation takes as input two values that are generally integer values. For example, if we identify the two values as 'a' and 'b', we have familiar mathematical formulas such as:

a + b, a – b, a * b, and a / b as well as:

a mod b (the modulo operation)

63. The modulo operation is well known and has been in use in computer science for decades. The modulo (aka modulus) operation is defined as giving a result that is the remainder after division of one number by another (such as the remainder of a / b). In other words, to find a

mod b, divide ‘a’ by ‘b’ to return a value (which may have a leftover fractional part if b does not divide evenly into a) and then return as the result just the leftover part. For example:

> 7 mod 3 = **<u>1</u>**   (3 goes into 7 twice, (2 * 3 = 6), and 7 – 6 = 1
>
> 4 mod 2 = **<u>0</u>** (2 goes into 4 twice with no remainder)
>
> 57 mod 10 = **<u>7</u>**

64. The patent also includes several dependent claims. For example: Claim 4 (and similarly claim 9) depends from claim 1 and recites the following:

> 4. The method of claim 1, wherein the ‘L’ CCEs corresponding to a first PDCCH candidate among the set of PDCCH candidates of the search space at the subframe k are contiguously located from a position given by:
>
> $L^* \{(Y_k)\mathrm{mod}(\mathrm{floor}(N/L))\}$

65. The “floor” operation in the above equation is another well-known operation that takes an input one value and outputs another value. The patent defines “floor” in the same way it is commonly understood: “floor(x) is a largest integer that is equal to or less than x.” ’332 Patent at 2:43-44.

66. Claim 5 (and similarly claim 10) recites:

> 5. The method of claim 1, wherein the ‘L’ CCEs corresponding to a first PDCCH candidate among the set of PDCCH candidates of the search space at the subframe k are located at positions given by:
>
> $L^* \{(Y_k)\mathrm{mod}(\mathrm{floor}(N/L))\} + i$ wherein $i = 0, \ldots, L\text{-}1$.

V. ’332 PATENT CLAIM CONSTRUCTION

A. Prior claim constructions related to the ’332 patent

67. I understand that in an earlier legal case concerning the ’332 patent, PanOptis[4] sued BlackBerry and asserted some of the same claims that are asserted in this case. In that

[4] I will refer to the plaintiffs in the BlackBerry case collectively as “PanOptis.” I may similarly refer to the plaintiffs in this case (listed on the title page of this declaration as “Optis.”

earlier case (which I may refer to as the *BlackBerry* case), I understand that the parties in that case agreed to a construction for the terms "search space of the PDCCH" / "search space" (for claims. 1, 5, 6 and 10). The agreed-upon construction was "a region that the UE needs to attempt to decode to receive a PDCCH." *Optis Cellular Tech. LLC v. BlackBerry Corp.*, 2:16-cv-00059-JRG-RSP, Dkt. 108 (E.D. Tex. 2017) ("BlackBerry Markman Order") at 10. (APL-UPPO_002435892.)

68. I also understand that the parties in the Blackberry case disputed some other terms, particularly:

No.	Term	PanOptis's Construction	BlackBerry's Construction
1	"set of PDCCH candidates within a search space" / "set of PDCCH candidates of the search space" (cls. 1, 5, 6 & 10)	No construction necessary.	one or more UE-specific PDCCH positions within a region that the UE needs to attempt to decode to receive a PDCCH
2	"given by using" / "given by"	No construction necessary.	Originally "corresponding to" Later, during briefing, agreed that no construction was necessary.

See id. at 13.

69. Ultimately, the Court in that case declined to construe Term No. 1, saying that is should be interpreted according to its plain and ordinary meaning. And BlackBerry agreed to a plain and ordinary meaning for Term No. 2.

70. Regarding Term No. 2, the parties originally disputed the meaning of the claim limitation "given by using" / "given by." PanOptis's original proposed construction was that no construction was necessary, while BlackBerry proposed a construction of "corresponding to." Ultimately, after PanOptis submitted their Opening Brief arguing that no construction was necessary, Defendant (BlackBerry) submitted that "there does not appear to be a substantive dispute over claim scope for the Court to resolve," and so agreed no construction was necessary.

Optis Cellular Tech. LLC v. BlackBerry Corp., 2:16-cv-00059-JRG-RSP, Dkt. 100 (BlackBerry Markman Reply) (E.D. Tex. Nov. 22, 2016) at 9 ("while PanOptis challenges BlackBerry's particular choice of words, there does not appear to be a substantive dispute over claim scope for the Court to resolve. BlackBerry, therefore, agrees that no construction is necessary for these terms."). (POAP_00004114 at 00004127.)

71. As part of its briefing, PanOptis alleged that the term "given by" is used "to refer to 'a position' that is 'given by' or 'given by using' followed by a description of how to calculate the position based on various parameters, depending on the claim. *See* Ex. 1, cls. 1, 5, 6, 10. It is entirely appropriate then to say that the position is 'given by' those calculations …." *Optis Cellular Tech. LLC v. BlackBerry Corp.*, 2:16-cv-00059-JRG-RSP, Dkt. 99 (Optis Opening Claim construction Brief) (E.D. Tex. Nov. 22, 2016) at 6. (APL-UPPO_002436008 at 002436017.)

B. Term 1: "wherein Y_k is defined by: Y_k =($A*Y_{k-1}$) mod D" (claims 1 and 6)

Apple's Construction	Optis's Construction
Indefinite	Plain meaning

72. I understand that the parties dispute the proper construction for the term "wherein Y_k is defined by: $Y_k=(A*Y_{k-1})$mod D," which appears in each independent claim. Specifically, I understand that Apple contends the term is indefinite, while Optis argues that the term should be given its "plain meaning," which Optis has not identified.

73. Based on the claims, specification, and file history of the '332 patent, one of ordinary skill in the art would not be able to determine the scope of the term "wherein Y_k is defined by: Y_k =($A*Y_{k-1}$) mod D" with reasonable certainty. In particular, the equation for the sequence Y_k does not describe the initial value for that sequence (e.g., the value Y_{-1} if the remaining sequence is Y_0, Y_1, Y_2, etc.). Without that value, the claims are indefinite. As

explained in more detail below, the problem with the claims in the ’332 patent is that each value of Y_k is defined based earlier values of Y_{k-1}, but no initial value is ever defined to prevent the definition from being endlessly circular.

1. The prosecution history of foreign counterpart patents to the ’332 patent confirms that the Y_k claim term is indefinite

74. Prior to addressing the technical issues for this claim term, I note that I am not the first person to conclude that the form of the Y_k equation in claims 1 and 6 of the ’332 patent is indefinite. Patent examiners in both the Korean and European patent offices each confirmed that the lack of an initial value for the Y_k equation would render these claims indefinite.

75. As background, I note that the ’332 patent states that it is a continuation based on a parent patent U.S. Patent No. 7,873,004 (“’004 patent”), and that the ’004 patent is a counterpart to an earlier version of that patent that was filed in the Korean Patent Office. ’332 patent at 1:8-14. That Korean patent application was application number 10-2008-0068633 (“KR ’633 Patent”). *See* ’004 File History at .pdf pp. 107-178 (original KR ’633 Patent) (APL-UPPO_002497329 at 7435-7506).

76. When the patentee presented the KR ’633 Patent application to the Korean Patent Office, the Office rejected claims that were of a similar form (in relevant part) to the Asserted Claims in the ’332 patent. For example, the original Korean claim 7 (which I have included in the translated form below) also defined y_k recursively, and as originally recited, the claim failed to define an initial value for the first value of the sequence y:

> 7. The method of any one of claims 1 to 4,
>
> wherein, when the specific sub frame is a sub frame at k times, the first constant value is “D,” and the first variable value is “C,”
>
> an index position corresponding to a value determined according to Zk=[(A·yk+B)modD]modC and yk=(A·yk-1+B)modD is used for the certain start position Zk at a kth sub frame, and

> the first variable value C is calculated according to C = floor(NCCE/LCCE)
>
> (A and B are respectively predetermined specific constant values, k is a sub frame index, NCCE is a number of total CCEs within the specific sub frame, LCCE is a number of CCEs included in the CCE aggregation, and floor (x) is a biggest integer equal to or less than x).

English translation of KR ’633 Patent at 43 (APL-UPPO_002569294-353); ’004 File History at .pdf pp. 286-359 (original KR ’633 Patent) (APL-UPPO_002497329 at 002497616-002497687.)

77. The Korean Patent Office rejected the claims. One reason for the rejection was that “Claims 7 and 16 do not recite the meaning of 'yk' and the initial value of it, thus the equations cannot be correctly recognized.” Prosecution History of U.S. Patent No. 7,873,004 (’004 File History) at .pdf pp. 179-180 (which includes excerpts from the Korean prosecution of the counterpart patent). (APL-UPPO_002497329 at 002497507-508.) Thus, the Korean Patent Office recognized the same indefiniteness problem that I have recognized in the ’332 claims and that I explain further below in this section.

78. Ultimately, I understand that the patentee amended the claims of the Korean counterpart patent to include an initial value, which the patentee called “the input value of the 1st subframe.” That added definition is emphasized and underlined in what the patentee told the U.S. Patent Office (during the prosecution of the U.S. counterpart to the Korean patent) was the final, allowed Korean claim 7 below:

> 7. The method according any one of claims 1 to 4, wherein the specific subframe is the "k"th subframe,
>
> the search space starts with a start position Zk in the "k"th subframe, the start position Zk is set as an index position corresponding to a value determined by equations of
>
> Zk =[(A· yk +B)modD]modC and yk = (A· Yk-i +B)modD,
>
> wherein "yk" indicates the first resultant value of the k-th subframe, and "yk_1" indicates the input value of the k-th subframe,
>
> wherein A and B denote predetermined constant values and "k" denotes a subframe index, and

<u>wherein the identification information value of the UE is used as the input value of the 1st subframe</u>.

Prosecution History of U.S. Patent No. 7,873,004 ('004 File History) at .pdf pp. 109 (English Translation of Allowable Claims in KR 10-2008-0068633) (APL-UPPO_002497329 at 002497437).

79. This amendment by the patentee indicates that the patentee did not dispute that an initial value for Yk was required for the claim to be valid.

80. A similar situation occurred in the European Patent Office. There, the examiner initially believed the claims of the European counterpart to the '332 patent's parent were missing an initial value, and the examiner rejected the claims for that reason. *See* EU '953 Prosecution History at 297 ("the point is here how to define the initial value of the recursion, about this question claim 1 is silent") (APL-UPPO_002496944 at 002497240.) The patentee responded by noting that it *had* defined the initial value in those claims and suggested that the examiner had apparently missed it. Prosecution History of the EP2093953 Patent at .pdf pp. 298-299. (APL-UPPO_002496944 at 002497241-43.) I explain this interaction in more detail in the next section, immediately below, but the concern of the EU Patent Office examiner (regardless of whether he missed the initial value definition) also supports my conclusion that the claims are indefinite for failing to provide an initial value for the Y_k formula.

81. I also note that by the time the patentee began to prosecute the parent '004 patent in the United States, the patentee appeared to recognize that an initial value for Y_k was necessary. For that parent '004 patent, the final, issued claims included the following claim 5, where I have emphasized and underlined the portion of the claim in which the initial value for the sequence y_k is defined:

5. The method of claim 1, wherein the specific subframe is the k-th subframe,

> wherein the search space starts at the start position, denoted as start position "Zk" which is in the k-th subframe wherein the start position Zk is set as an index position and is determined according to a first equation of:
>
> Z_k=[(A·y_k+B)mod D]mod C
>
> wherein "A" and "B" each denote a predetermined constant value, "k" denotes a subframe index and "yk" denotes the first resultant value of the k-th subframe, and
>
> wherein "y_k"[5] is determined according to a second equation of:
>
> y_k = (A·y_{k-1} +B)modD
>
> wherein "y_{k-i}" denotes value of the k-th subframe and **<u>an identification information value of the UE is used as the input value of a first subframe</u>**.

'004 patent, Claim 5. (APL-UPPO_002497782-809.)

82. Despite seeming to recognize that the claims required the initial value to be defined, the patentee ultimately omitted the definition for the initial value in the claims of the '332 patent.

2. The claims define Y_k recursively

83. Each of the Asserted Claims in the '332 patent recites a numeric sequence called "Y" that is defined by the following equation:

$$Y_k = (A*Y_{k-1}) \bmod D$$

84. Each of the values of the sequence Y_k depends on the subscripted parameter 'k' taking on a value within a set of numbers, such as Y_1, Y_2, Y_3, etc., where k could (in this example) include the values 1, 2, and 3. Y_k is not a single number as people are more accustomed to seeing, such as in the simpler equation Y = 5 + 2. Instead, the claimed equation encompasses a set of values for Y_k, each for a different value of the index 'k'.

[5] I note that part of the subscript 'k' in '004 claim 5 appears cut-off in the final, issued printed patent and looks like an 'l'. However, it is clear from the allowed form of the claim in the prosecution history that 'k', and not 'l', was intended. ('004 Prosecution History at .pdf pp. 100) (APL-UPPO_002497329 at 002497428.)

85. The claimed equation for Y_k is what is known as a “recursive” equation because each value of Y_k—such as Y_5—is defined based on the numerically-previous version of Y (in this case Y_{k-1})—such as Y_4. This type of equation may at first seem endlessly circular when one considers the question of when the computation ends. I will discuss this potential problem after first discussing recursion generally.

86. As background, a recursive equation (or more generally a recursive function or method) is one that defines successive values in terms of the values that came before. Some definitions of such recursive functions from textbooks are:

- “Recursion is a method to solve a problem where the solution use[s] the solution resulting from smaller instances of the same problem (compared to iteration)”
    - (R. Hidayat, *Implementation of a Recursive Algorithm to Determine the Determinant of n x n Matrix Using Cofactor Expansion*, Proc. Int’l Conf. Sci. Engin. Vol. 2, pp. 245-248 (2019) at 246.) (“Hidayat”) (APL-UPPO_002494287 at 002494288.)

- “A method that is partially defined in terms of itself is called recursive.”
    - (M. Weiss, DATA STRUCTURES & PROBLEM SOLVING USING JAVA (4th ed. 2010), at 293.) (APL-UPPO_002497810 at APL-UPPO_002498139.)

87. This understanding of recursion generally, and recursive equations and mathematical functions specifically, has not changed for many decades. (“Recursive function theory can be traced to its origin since around 1931 about primitive recursive (Kleene, 1981).”) Hidayat at 245. (APL-UPPO_002494287.) I note that textbooks and articles from after the alleged filing date of the ’332 patent are generally just as relevant for providing information about recursion as from prior to that date because the meaning of recursion and the rules surrounding its use have not changed through this time.

88. Recursion and recursive functions such as Y_k are generally taught at the undergraduate level, as reflected in various course presentations from institutions such as Carnegie Mellon University and the University of Massachusetts:

- "Recursion is the concept of well-defined self-reference."
    - (C. Burch, CMU, Course Presentation - Recursion (Excerpts) (1990) at 4 (available at https://www.cs.cmu.edu/~cburch/survey/).) (APL-UPPO_002494166 at 002494169.)

- "Three Rules for Recursive Algorithms
  • A recursive algorithm is one that calls itself with a different parameter. For example, we might calculate the factorial n! by using a recursive call to compute (n-1)!, then multiply the result by n.
  • In CMPSCI 187, I teach three rules -- three properties to check in order to verify the correctness and termination of a recursive algorithm:
  • The algorithm must have a base case where it gets an answer without further recursion.
  • Every recursive call must make progress towards the base case.
  • If every recursive call terminates and gives the correct output, the original call will terminate and give the correct output."
    - (D. Barrington, U.Mass - CMPSCI250 Presentation - Introduction to Computation (Mar. 14, 2013) at 3 (available at https://people.cs.umass.edu/~barring/cs250s13/lecture/14.pdf).) (APL-UPPO_002494009 at 002494011.)

89. As a recursive definition, each value Y_k in the Asserted Claims is defined recursively in terms of an equation that is itself based on the prior value, Y_{k-1}.

90. An example of recursion that is similar to the definition of Y_k in the Asserted Claims is provided in one textbook that states that a "function that is defined in terms of itself is called recursive" and then provides the following equation:

$$f(0) = 0 \text{ and}$$

$$f(x) = 2f(x - 1) + x^2$$

M. Weiss, Univ. of Chile, DATA STRUCTURES AND ALGORITHM ANALYSIS at 13-14. (APL-UPPO_002495315 at 002495327-28.)

91. The above recursive function defines a function called "f" for different input values of 'x' (much like the different values of 'k' in Y_k). Using the subscript notation in the '332 patent, each non-zero sequence value is defined based on earlier values in the sequence just like the patent:

$$f_0 = 0 \text{ and}$$

$$f_x = 2f_{x-1} + x^2$$

92. Thus, to find the value of f_3—also known as f(3)—the calculation is computed as:

$$f_3 = 2f_{2\,+}\,(3)^2$$

$$f_2 = 2f_{1\,+}\,(2)^2$$

$$f_1 = 2f_{0\,+}\,(1)^2$$

$$f_0 = 0$$

93. Working our way back "up" from the initial base value of f_0, we have the following calculations:

$$f_0 = 0$$

$$f_1 = 2f_{0\,+}\,(1)^2 \;= 2*0 + 1 = 1$$

$$f_2 = 2f_1 + (2)2 \;= 2*1 + 4 = 6$$

$$f_3 = 2f_{2\,+}\,(3)^2 \;= 2*6 + 3^2 = \underline{\mathbf{21}}$$

94. I note that—unlike the definition of Y_k in the Asserted Claims—the equation above provides an initial value for f_0, namely 0. That definition prevents the equation from otherwise being not solvable.

95. The patentee, as well as the patent examiner, described the definition used in the Asserted Claims for Y_k as being "recursive" in nature. As I mentioned in the preceding section, in a related European patent to the '332, the examiner initially rejected similar claims to the Asserted Claims because those claims failed to define an initial value for the sequence that defines Y_k in the '332 patent. As part of that rejection, the examiner characterized that equation as recursive. Specifically, the examiner said that "claims 1 and 2 are silent about how to define the initial value *of the recursion*." EU '953 Prosecution History at 298. (APL-UPPO_002496944 at 002497241.)

96. Although the examiner may have been ultimately incorrect about whether the initial value was defined for that patent, he was correct about the recursive nature of the equation, and the patentee subsequently agreed to that characterization. Specifically, the patentee said that "it is respectfully noted that claim 1 indeed defines the initial value ***of the recursion***: 'x-1 is initialized as an identifier of the UE'." EU '953 Prosecution History at 300 (APL-UPPO_002496944 at 002497243) (emphasis added); *see also id*. at 297 (where the examiner noted that "Since recursive functions are well used in the prior art the skilled person would of course make use of such a relationship when moving from a subframe to the next one, the point is here how to define the initial value of the recursion, about this question claim 1 is silent.") (APL-UPPO_002496944 at 002497240.) I generally agree with that characterization of Y_k as a recursive function or definition. However, as I just explained, the recursive definitions in the Asserted Claims are ambiguous are indefinite because the initial value for the sequence (sometimes known as a "base case") is not defined.

97. The equation at issue in the EU patent prosecution was similar in relevant part to the Y_k equation in the claims of the '332 patent. During the prosecution of that earlier EU patent (which I understand is the European counterpart to the parent patent of the '332 patent), the patentee referred to the sequence "x", not "Y". However, "x" in that patent corresponds to "Y" in the wording used in the '332 patent as is evident from the sequence defined in the EU '953 patent. That equation: "X_i= (A *x_{i-1} + B) mod D" (*see id*. at 299 (APL-UPPO_002496944 at 002497242) is similar to the equation for Y_k: $Y_k = (A*Y_{k-1}) \bmod D$., because the addition of the constant B does not affect whether the equation is recursive. As explained above, the "Y_{k-1}" aspect of the equation (and the X_{i-1} aspect of the equation in the EU '953 counterpart patent) is what makes it recursive.

98. Just as the question that the European patent examiner asked for the EU counterpart patent, one question for the ’332 patent is what part of the sequence Y_k is meant to represent the beginning initial base value? The specification for the ’332 patent identifies either Y_{-1} or Y_0, as representing the first number in the sequence. For example, the first 5 values in the sequence could be identified either as {Y_0, Y_1, Y_2, Y_3, and Y_4} or {Y_{-1}, Y_0, Y_1, Y_2, and Y_3}. The value k is recited as corresponding to “the subframe k,” and as such the formula for Y_k provides a number for each subframe in a PDCCH radio frame. *See* ’332 patent at 20:40-44. In each case, the value of Y_k for the numerically-first subframe would be defined in terms of either Y_{-1} or Y_0. For the remainder of this declaration, I may refer to Y_0 as the initial value for the sequence Y, but in doing so I mean to also encompass equations in which Y_{-1} is the initial value for the sequence.

99. The problem with the claims in the ’332 patent is that neither Y_{-1} or Y_0 nor any other initial base value for the sequence Y is ever defined.

3. Recursive definitions without an initial base case are indefinite

100. As the textbook using the f(x) example I just cited explained, “declaring f(x) = 2 f(x - 1) + x2 is meaningless, mathematically, without including the fact that f (0) = 0.” M. Weiss, Univ. of Chile, DATA STRUCTURES AND ALGORITHM ANALYSIS at 13-14. (APL-UPPO_002495315 at 002495327-28.) In other words, one of ordinary skill in the art would understand that an attempt to define f(x) recursively without the initial base case of “f(0) = 0” would not make sense. Lacking such a base case, the scope of the equation is undefined, and none of the subsequent values can be calculated.

101. I understand that a term is indefinite if it does not provide one of ordinary skill in the art with reasonable certainty about the scope of the term. A person of ordinary skill in the art would not be able to ascertain the scope of an equation that is not properly defined

mathematically because that definition is what would otherwise provide that certainty of scope. For that same reason, the ’332 patent’s use of ill-defined equations as claim terms result in those claims terms being indefinite.

102. Numerous textbooks and articles confirm that a recursive definition that lacks a base case is not properly defined mathematically:

- A “well-defined recursive function must satisfy two conditions: 1. There must be a base criterion for which the function should not call itself….”
  - A. Alisha, Computer Science with C++ for class XII (excerpts) (2001) at 244 (APL-UPPO_002494001 at 002494006.)

- “Just as declaring f(x) = 2 f(x - 1) + x2 is meaningless, mathematically, without including the fact that f (0) = 0, the recursive C function doesn't make sense without a base case.”
  - M. Weiss, Univ. of Chile, Data Structures and Algorithm Analysis at 14 (available at http://www.ce.kmitl.ac.th/download.php?DOWNLOAD_ID=3858&database=subject_download) (APL-UPPO_002495315 at 002495327-28.)

103. Curriculum and presentations from undergraduate courses also confirm that recursive definitions must have defined base cases or will otherwise be indefinite without them:

- “How can you tell if a recursive definition is well-defined? Here's one easy way that often applies: If each time you recurse you are significantly closer to the base case, then the definition isn't circular”
  - C. Burch, CMU, Course Presentation - Recursion (Excerpts) (1990) at “Avoiding circularity” (available at https://www.cs.cmu.edu/~cburch/survey/) (APL-UPPO_002494166 at 002494171.)

4. None of the Asserted Claims provides an initial value for Y_k

104. The Asserted Claims define only “$Y_k = (A*Y_{k-1}) \bmod D$”. The claims do not define a base case or initial value where the recursive formula stops recursing and has a defined value, such as Y_0 (from which Y_1 might be calculated) or Y_{-1} (from which Y_0 might be calculated). I may refer to the (missing) “base case” for the definition of Y_k as the “initial value” because it is the starting point from which all other values of Y are computed.

5. Selection of the initial value is fundamental to the alleged invention

105. The patent suggests that the selection of the initial value for the recursive definition of Y_k is a fundamental aspect of the alleged invention. There are several reasons for this.

106. First, the ’332 patent explains that certain initial values will not work for the patent’s stated purpose. Specifically, the patent indicates that if different UEs fail to be assigned to different search spaces, the patent’s goal is not met, and in some cases a UE may not receive its control information. The patent states that “FIG. 10 illustrates an example wherein one of two UEs having different CCE aggregation levels fails to receive a PDCCH destined for the UE….A problem may occur if the CCE region for PDCCH decoding is the same for all UEs even though their CCE aggregation levels are different.” ’332 patent at 11:23-29.

107. A second reason that the selection of the initial value is fundamental is that according to the patent, the alleged “basic purpose of each embodiment of the present invention is to generate a different value for any specific [UE] identification number, which will also be referred to as an ‘ID’ for short, and thus it is preferable to select an initial value which maximizes randomization effects according to the ID.” ’332 patent at 10:26-31; *see also id.,* 10:32-43. A person of ordinary skill in the art would recognize that not all potential initial values would achieve this purpose. For example, initial values that were not related to the UE IDs would not be guaranteed to generate different values for each UE, and certainly would not “maximize[] randomization effects according to the ID.”

108. A third reason that the selection of the initial value is fundamental to the alleged invention is that one goal of the patent is to synchronize the searching of PDCCH regions as between the base station (which selects which regions to place data in) and the UE (which looks in those regions for data). ’332 patent at 12:51-59 (“The PDCCH decoding region should be

synchronized between the base station and UEs and the period and timing of generation of an identification dependent randomization number should also be synchronized between all UEs that communicate with the base station. Thus, overlapping of PDCCH decoding regions can be minimized if identification-dependent randomization numbers that UEs having different UE IDs use every sub frame are different.”). Thus, the initial value must be known between both the base station and each respective UE with which the base station is communicating.

109. However, without a requirement for a well-defined value for the initial value of Y, there will not be a value that both the base station and UE would have agreed upon. Leaving the initial value undefined would mean that the UE would not know where to expect the base station to have placed that UE’s data and the UE might need to exhaustively search all possible locations.

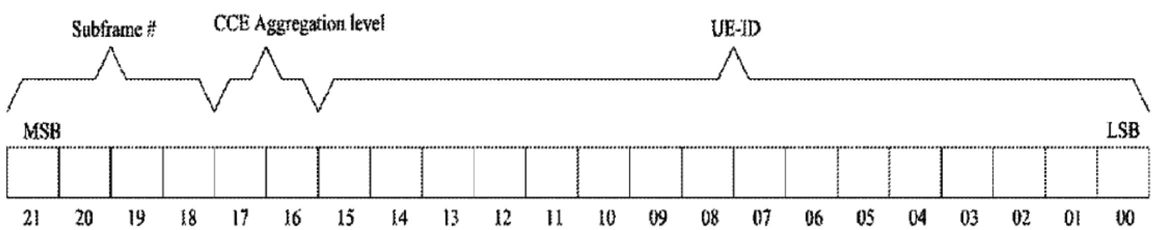
6. Without a defined initial value for the sequence Y, a person of ordinary skill in the art would not know the scope of the claims

110. A person of ordinary skill in the art, looking at the Asserted Claims, would not be able to ascertain the scope of those claims because the initial value for the recursively-described Y_k sequence is not defined. As such, a person of ordinary skill in the art would also not know (let alone know with any certainty) what initial value or values the patentee meant to encompass as potential initial values. Nor would such a person be able to understand what potential sequences of Y_k are claimed. There are several reasons for this uncertainty.

111. First, the fact that the ’332 patent spends a considerable amount of time discussing potential initial values for Y indicates that those potential values are not well known. The patent spends two columns of text describing and analyzing a number of “ID dependent” values that it says may be used for the initial values. *See, e.g.*, ’332 patent at 10:33-12:10. This work would not have been necessary if such values were known.

112. Second, the patent specification shows that one of ordinary skill would not be aware of all possible initial values that could be used for the sequence Y. Instead, the patent indicates that there are many possible values, each consisting of different combinations of different potential sub-components, each of which might be used as an initial value for the recursive definition of claims 1 and 6. *See, e.g.*, Figs. 8, 9, and 11-14, 12:29-30 (noting that in addition to the potential values suggested in Figures 8, 9 and 11-14, "Another possible method is to use only the UE ID as an initial value while especially using fixed, constant values as the values A, B, and D in the first to fifth embodiments."). For example, the patent describes Figure 11 (shown below in Illustration 5) as an "an example wherein the initial value includes a subframe number, a CCE aggregation level, and a UEID at bit positions sequentially from the MSB to the LSB positions":

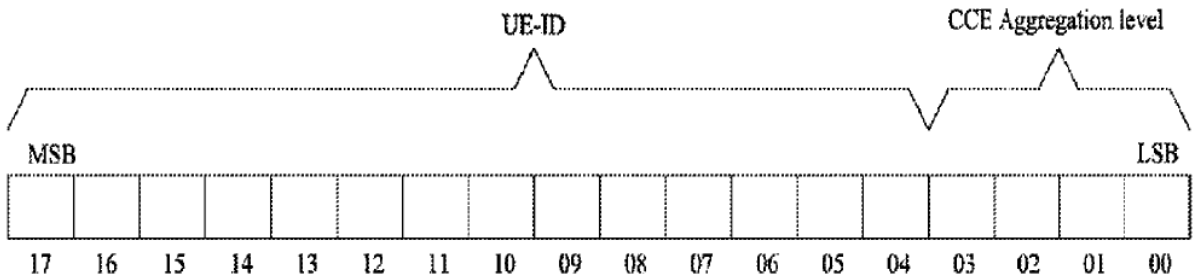
Illustration 5



'332 patent at 11:50-53; *see also id*. at 4:9-11.

113. In contrast, the patent describes Figure 14 (shown below in Illustration 6) as "including a CCE aggregation level and a UE ID at bit positions in the reverse order [the reverse of sequentially from the MSB to the LSB] in the example of FIG. 13":

Illustration 6



’332 patent at 12:5-10; *see also id*. at 4:13-17.

114. The patent indicates that the various possible initial values just described are not the full universe of possibilities. The patent specification does not provide a complete set of potential values despite that fact that some values would not work well or would not work at all. Instead, the patent indicates that the possibilities are largely limitless by disclosing various broadening statements about those possibilities including the following:

- ’332 patent at 11:56-57 (“These information items may be arranged in any other order, provided that the initial value includes all the information items.”);
- *Id*. at 12:9-10 (“the CCE aggregation level and the UE ID may be arranged in any order”); and
- *Id*. at 10:32-43 (“Since the purpose of each embodiment of the present invention is to impart randomization effects of PDCCH decoding regions between UEs and a base station and it is not necessary to take into consideration randomization effects between base stations, ID values for identifying UEs such as UE identification numbers (for example, a C-RTNI or a temporary-RNTI) can be selected as initial values. Specifically, all of the following information items or combinations thereof can be used to create initial values.
    - o 1. UE ID
    - o 2. CCE aggregation Level (L)
    - o 3. Subframe Number (or Slot Number)”

115. The patent also acknowledges that even if a particular potential initial value were chosen as the initial value for the recursive definition of Y_k, other values might still be used at different times even within the same radio frame. Whatever the initial value is, it might be

generated anew every subframe, or only once for every frame, and the initial value may or may not include overlapping UE ID and subframe numbers. ’332 patent at 10:44-61.

116. A person of ordinary skill, looking at these statements and at the variations in the various figures of the patent, would recognize that there are no ascertainable bounds on the number of possible initial values for Y_k , or on the possible resulting sequences of Y.

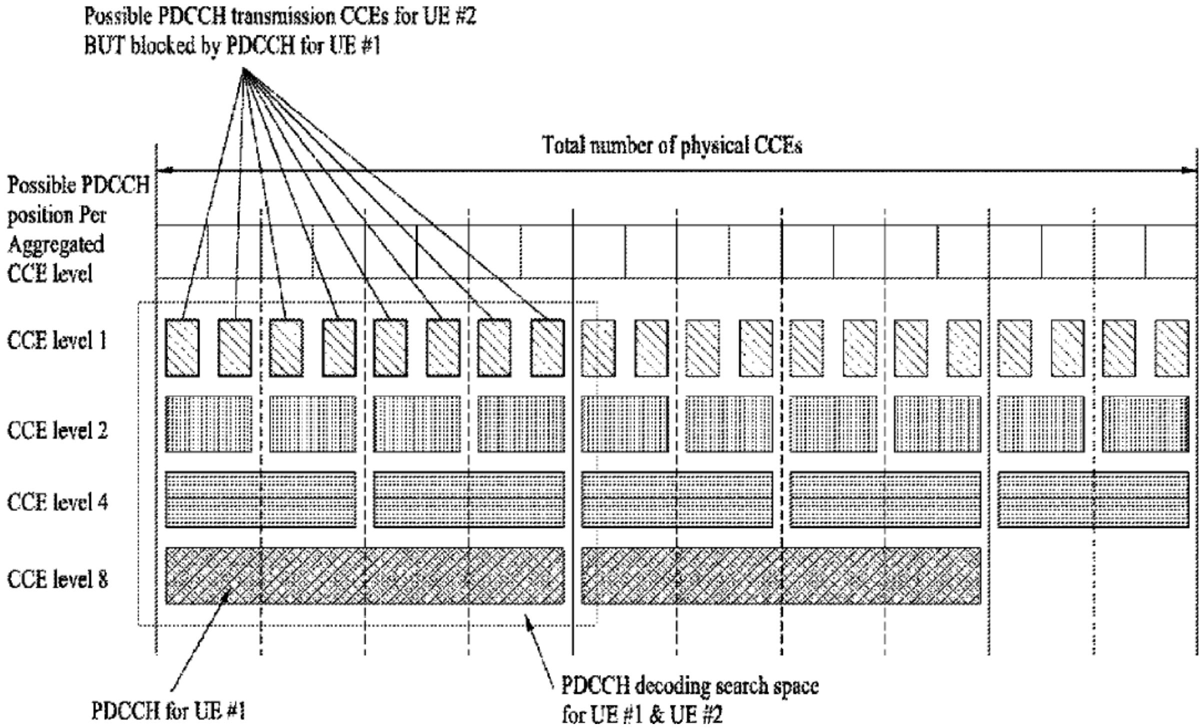
7. The patent acknowledges that some initial values will not work, so the initial value or values cannot encompass *all* values

117. A further complication in attempting to determine the scope of the potential initial values for Y_k is that the scope cannot simply be “any value.” Instead, a person of ordinary skill in the art would recognize that there are various subsets of potential values would not work.

118. A simple example of this principle is to use the value ‘0’ for the initial value. In that case, each and every subsequent computation of Y_k will multiply an earlier zero value by some other numbers, resulting in zero. And any modulo operation on 0 results in 0. Thus the sequence Y_k will be { 0, 0, 0, 0, etc.}. Such a sequence would effectively be non-functional because all UE data would be put in the first CCE in each subframe.

119. As another example that the patent acknowledges, the patent notes that “FIG. 10 illustrates an example wherein one of two UEs having different CCE aggregation levels fails to receive a PDCCH destined for the UE….A problem may occur if the CCE region for PDCCH decoding is the same for all UEs even though their CCE aggregation levels are different.” ’332 patent at 11:23-29. To illustrate that example, if an 8-CCE-wide PDCCH is used for “UE #1” as shown in the lower-left corner of Fig. 10, and if the only PDCCH candidates for “UE #2” were the single CCEs (aggregation level L=1) shown in the upper-left of the figure, then each of those “possible PDCCH transmission CCEs for UE #2” are effectively “blocked by PDCCH for UE #1”:

Illustration 7



’332 patent at Fig. 10; *see also id*. at 5:5-8 (“FIG. 10 illustrates an example wherein one of two UEs having different CCE aggregation levels fails to receive a PDCCH destined for the UE due to a PDCCH destined for the other UE.”).

120. In addition, as I noted above, the patent states that all disclosed embodiments are directed at generating a different search region starting value for any specific UE identification number. ’332 patent at 10:26-43 (the “basic purpose of each embodiment of the present invention is to generate a different value for any specific identification number, which will also be referred to as an ‘ID’ for short, and thus it is preferable to select an initial value which maximizes randomization effects according to the ID.”). One of ordinary skill in the art would recognize that many potential initial values for Y_k would fail to achieve this purpose, and that some values would provide no randomization at all. Again, a simple example would be to use “0” as the initial value (Y_0 or Y_{-1} if the initial value is at index -1) for each UE in the system.

121. For all the reasons I have just identified, the claim term "wherein Y_k is defined by: $Y_k = (A*Y_{k-1}) \bmod D$" does not provide one or ordinary skill in the art with any certainty (let alone a reasonable certainty) about the scope of the term. For that reason, the claim term "wherein Y_k is defined by: $Y_k = (A*Y_{k-1}) \bmod D$" is indefinite.

C. Term 2: A position "given by using a variable of Y_k for the subframe k and a modulo 'C' operation" (claims 1 and 6)

Apple's Construction	Optis's Construction
"given by one of: $L \cdot [(A \cdot Y_k + B) \bmod D] \bmod C$ or $L \cdot (Y_k \bmod C)$"	Plain meaning

122. I understand that the parties dispute the proper construction for the term "given by using a variable of Y_k for the subframe k and a modulo 'C' operation," which appears in each independent claim. Specifically, I understand that Apple contends the term should be construed as "given by one of: $L \cdot [(A \cdot Y_k + B) \bmod D] \bmod C$ or $L \cdot (Y_k \bmod C)$," while plaintiffs argue that the term should be given its "plain meaning," which plaintiffs have not identified.

123. Based on the claims, specification, and file history of the '332 patent, one of ordinary skill in the art would understand the term "given by using a variable of Y_k for the subframe k and a modulo 'C' operation" to mean "given by one of: $L \cdot [(A \cdot Y_k + B) \bmod D] \bmod C$ or $L \cdot (Y_k \bmod C)$." As such, this term would encompass each of what the patent identifies as "Mathematical Expressions" numbers 4 and 6. Those two expressions are the only expressions in the patent specification that give (e.g., calculate) a value that is in "CCE-based" units (described above) as required by the form of the claims.

1. One of ordinary skill in the art would understand the claims as "giving" a position, not just identifying variables that could be used to do so

124. Both claims 1 and 6 recite the following:

> "a position given by using a variable of Y_k for the subframe k and a modulo 'C' operation"

125. One of ordinary skill in the art would understand this claim limitation as giving (e.g., determining and providing) a particular "position" value using a mathematical formula that uses as input the variable Y_k and also incorporates the use of a "modulo 'C'" operation. I understand that PanOptis agreed to essentially this same interpretation ("giving") during its earlier case against BlackBerry. *Optis Cellular Tech. LLC v. BlackBerry Corp.*, 2:16-cv-00059-JRG-RSP, Dkt. 99 (E.D. Tex. Nov. 22, 2016) at 6 ("The disputed terms are used in the asserted claims to refer to "a position" that is "given by" or "given by using" followed by a description of how to calculate the position based on various parameters, depending on the claim. See Ex. 1, cls. 1, 5, 6, 10. It is entirely appropriate then to say that the position is "given by" those calculations"). (APL-UPPO_002436008 at 002436017.)

126. In addition, the dependent claims in the '332 patent confirm Apple's construction. In dependent claim 9, for example, what follows the phrase "given by" is a mathematical expression that gives a position. *See* claim 9 ("wherein the 'L' CCEs corresponding to a first PDCCH candidate among the set of PDCCH candidates of the search space at the Subframe k are contiguously located from a position given by: $L*\{(Y_k)\mathrm{mod}(\mathrm{floor}(N/L))\}$.").

127. A contrary interpretation would claim ***any*** combination of the Y_k sequence and the mod C operation regardless of the formula. Such an interpretation could not be correct because not all such combinations would provide the type of start position that these claims require to be "given."

2. The claims cannot encompass all mathematical expressions in the patent

128. As an initial matter, it is clear on their face that the claims cannot cover Mathematical Expression 7. That expression is defined by:

$$Z_k = ((A \cdot x_k + B \cdot x_k^2) \bmod D) \bmod C$$

129. The format of Expression 7 is a "quadratic" equation, because it is based on variables whose highest exponent is 2, as in the "x_k^2" part of the equation. A person of ordinary skill would understand that such quadratic equations are fundamentally different (and behave fundamentally differently) from the equation in the Asserted Claims:

$Y_k = (A * Y_{k-1}) \bmod D$,

130. For this reason alone, the Asserted Claims cannot be understood to cover all embodiments in the patent.

3. Not every conceivable combination of Y_k and a modulo 'C' would "give" a start position as required by the claims

131. Much as a person of ordinary skill in the art would understand that not every potential initial value of Y would work in the context of the '332 patent claims, not every potential combination of a variable defined in the manner Y_k is defined in combination with a modulo 'C' operation would provide a start position as required by the claims. This is easily shown by examining counterexamples where these two variables are used as input to an equation but would not result in a start position.

132. A simple counterexample would be flipping the order of 'L' and Y_k in Mathematical Expression 6 (i.e., $Y_k \cdot (L \bmod C)$, where $C = \text{floor}(N_{CCE,K}/L)$, instead of $L \cdot (Y_k \bmod C)$). That resulting expression would not identify a start position and would instead return the product of the same two integers (one between 0 and C-1 and the other between 0 and D-1) that comprise the original Expression 6.

133. For the above reasons, there would be no way the information provided in the patent could enable a person of ordinary skill to practice all possible combinations of Y_k and Mod C. For that reason, I would expect one of skill in the art to turn to the mathematical

expressions given in the specification for guidance on which (if any) expressions the claimed Y_k formula was meant to cover.

4. The patent discusses two alternative ways to provide search space positions: on a "CCE basis," and on a "CCE-aggregation" basis

134. As I noted above in Section IV.A, above, the '332 patent distinguishes between two classes of equations—(1) those that give a CCE position/location within a frame (for L=4, the position could be 0, 4, 8, 12, etc.); and (alternatively) (2) those equations that give an index (ordinal) of an *aggregated* CCE at which the search is to begin (for L=4, the index could be 0, 1, 2, etc. signifying the first, second or third 4-CCE-wide aggregated CCE). *See* Illustration 2, above. The patent makes this distinction in several ways.

135. First, the specification explains that the start position can be given "based on an index assigned to each CCE" or, alternatively "an index assigned to each CCE aggregation." '332 patent at 9:17-23. "That is, when the CCE aggregation level is '2', a CCE aggregation index may be assigned on a CCE basis rather than on a 2-CCE basis." *Id.*; *see also id.*, 9:5-10 (explaining that in the first embodiment "the finally obtained search space start position Z in the subframe corresponding to the index "k' indicates a corresponding one of the indices assigned to CCE").

136. Second, the "Summary of the Invention" also distinguishes between these options, saying of one embodiment: "the index position corresponding to the determined value [a CCE index value] may correspond to a start position of a CCE aggregation corresponding to the determined value under the assumption that indices are assigned on a CCE aggregation basis." '332 patent at 3:29-32. As discussed later in the specification, that "correspondence" is that the CCE index position is the aggregation position multiplied by the number of CCEs within each aggregation, 'L'. '332 patent at 9:17-30 (showing multiplication by 'L_{CCE}'.)

137. Third, the patent reinforces the distinction between these two types of numbers by calling out separate embodiments and "mathematical expressions" for each type of result. *Compare* 8:17 (first embodiment with Mathematical Expression 3) *to* 9:29 (second embodiment with Mathematical Expression 4).

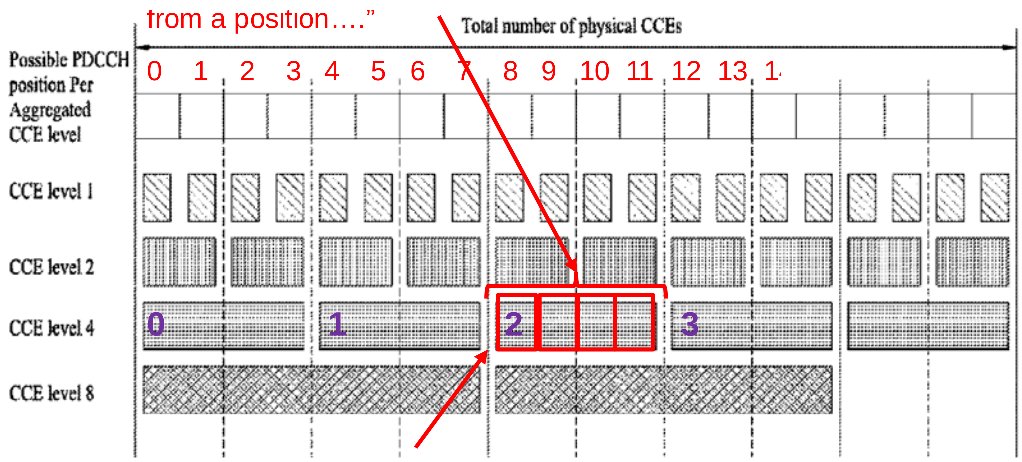
5. One of ordinary skill in the art would understand that the "position" in claims 1 and 6 is given in terms of CCEs, not CCE-aggregations because each of the 'L' CCEs is "contiguously located from" that position

138. Each Asserted Claim requires the calculation of a particular "position." As recited in claims 1 and 6, that position is such that each group of CCEs are required to be "contiguously located from" the position:

> "…wherein **the 'L' CCEs** corresponding to a specific PDCCH candidate among the set of PDCCH candidates of the search space at the subframe k **are contiguously located from a position** given by using a variable of Y_k for the subframe k and a modulo 'C' operation…."

139. Based on the specification and the figures it contains, one of ordinary skill in the art would interpret the term "contiguous" in a physical sense, because the blocks within a subframe have a physical location in the patent figures that represents each CCE's position within that subframe.

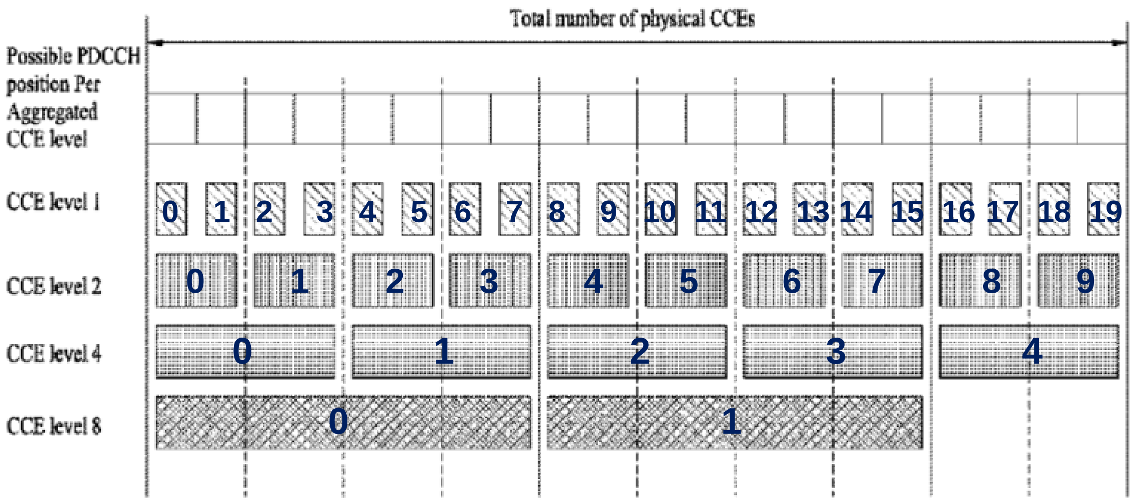
Illustration 8



140. Specifically, the “contiguous” requirement shows that the “position” from which the CCEs are “contiguously located” is a position that is a ***location*** within the various possible CCE positions in the subframe and not simply an index number of a block. In other words, the “position” that is given by the claim is given in CCE-based units, not CCE-aggregation-based units.

141. In contrast, it would make no sense to describe a set of CCEs as being “contiguous” to an index number because the index has no direct physical location within a subframe. A CCE-aggregation index is a just an ordinal number that can occur anywhere, as shown below for different levels of aggregation:

Illustration 9



142. As shown above in Illustration 9, above, a CCE-aggregation-based number can exist in any number of different locations within the subframe depending on the aggregation level. And for levels greater than 1, the CCE aggregation is not well-defined physically because it can take up multiple potential positions in the subframe. For all these reasons, CCE-based, not CCE-aggregation-based numbers are the only numbers that make sense in the Asserted Claims.

6. One of ordinary skill would understand dependent claims 4, 5, 9, and 10 to show that parent claims 1 and 6 each produce a start position in units of CCEs, not in units of CCE aggregations

143. The use of the term "position" in the claims that depend on claims 1 and 6 also indicate that the term "position" is claimed in terms of CCEs, not in units of CCE aggregations because those dependent claims would not make sense if the independent claims used "position" in units of CCE aggregations.

144. As an initial matter, a person of ordinary skill in the art would understand that the term "position" in claim 1 would have its same meaning when recited in the dependent claims, including claims 4 and 5, especially because there is no suggestion in the claims or the

specification to the contrary. The same goes for dependent claims 9 and 10 and parent claim 6. And as I explain next, when that term is used in the dependent claims, "position" is used in a manner that is unmistakably a CCE-based number. Thus, the "position" recited in claims 1 and 6 as "given by using a variable of Y_k for the subframe k and a modulo C operation" must be given by an equation using those two inputs in a manner that produces a CCE-based position. There are several reasons that the "position" in the dependent claims is clearly a CCE-based number.

145. First, the form of the equations in dependent claims 4 and 5 (for parent claim 1) and 9 and 10 (for parent claim 6) shows that the position is CCE-based. One of skill in the art would recognize the equations in the dependent claims as producing only CCE-based numbers because each is "L * <some number>":

Claims 4 & 9:

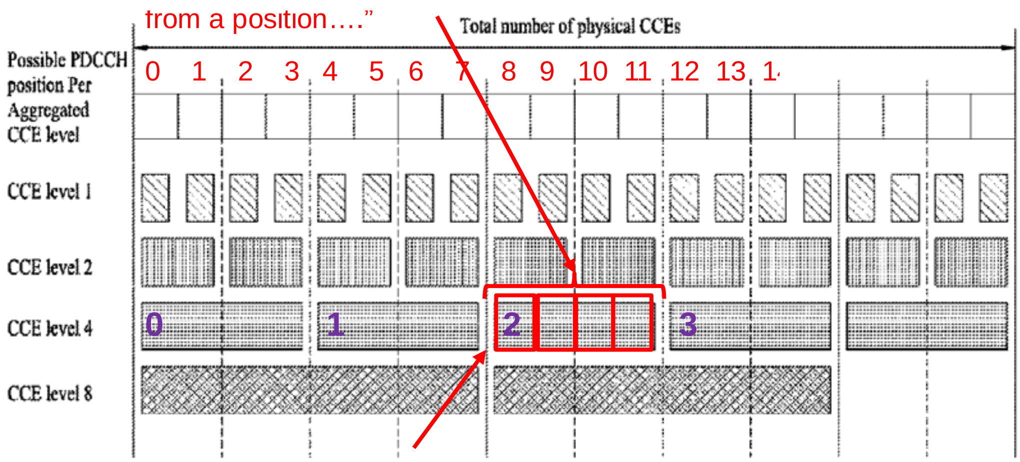
$$L^* \{(Y_k)\mathrm{mod}(\mathrm{floor}(N/L))\}$$

Claims 5 & 10:

$$L^* \{(Y_k)\mathrm{mod}(\mathrm{floor}(N/L))\} + i \quad \text{wherein } i = 0, \ldots, L\text{-}1.$$

146. As I discussed above, to convert from CCE-aggregation-based numbers to CCE-based numbers, it is necessary to multiply the former by the aggregation level, 'L'. That multiplication is exactly what is shown in claims 4, 5, 9, and 10. As an example, for L=4 and CCE aggregation index=2, L * 2 = 4 * 2 = 8 (a CCE-based position as shown in <u>Illustration 10</u>, below.

Illustration 10

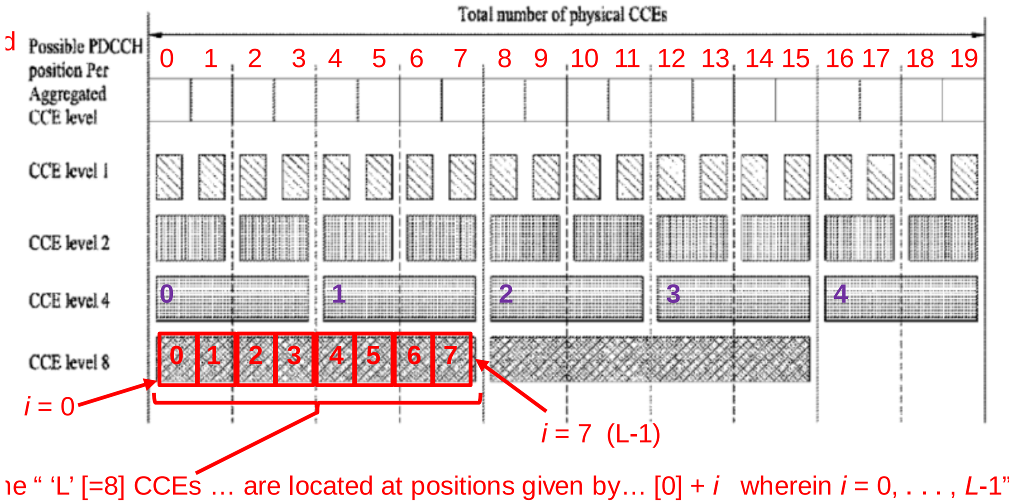


147. A second reason it would be evident to one of ordinary skill in the art that the claims give positions in terms of CCE-based units is that dependent claims 5 and 10 recite "wherein the 'L' CCEs corresponding to [and comprising] a first PDCCH candidate…are located at positions given by" a set of numbers that rise sequentially by 1, which are values that would not make sense if they were interpreted as CCE aggregation indices. Specifically, the use of the variable "*i*" in claims 5 and 10 confirms that the recited "position" is CCE-based because "*i*" is defined as the set of integers (which increase sequentially (one by one) from 0 to L-1.

148. Here I provide an example for aggregation level L=8, where for claim 5 *i* would be the sequence { 0, 1, 2, 3, 4, 5, 6, 7 }. That sequence means that wherever the starting position is, each of the respective CCEs in an 8-CCE-block-aggregation will be '1' position away from the prior CCE. This is shown in my example in Illustration 11 below, with the assumption that the 0^{th} position for Y_k would be the value of zero:[6]

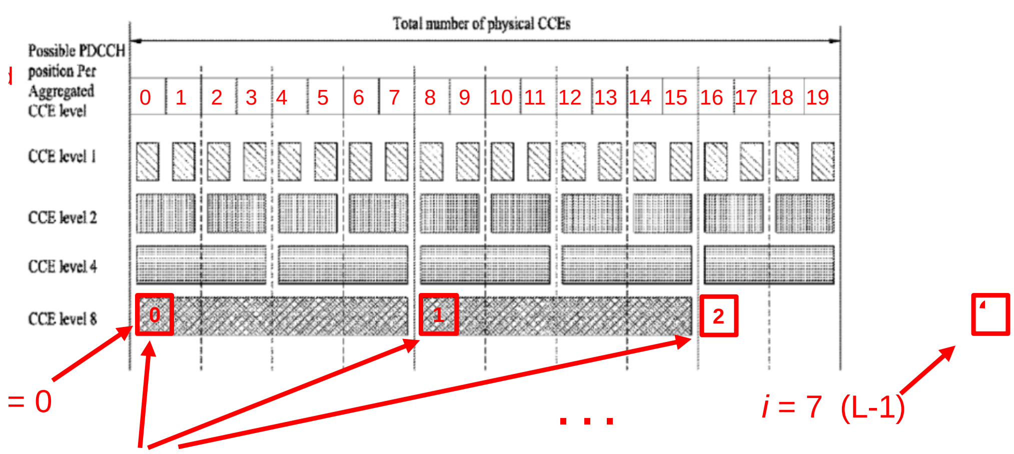
[6] I could pick any value for the starting position for this example but picking 0 removes any pre-assumption of units because the 0^{th} starting position will be the same physical position in the subframe regardless of what units are used for the position value.

Illustration 11



149. Next, I compare the above scenario (which uses the correct interpretation of a CCE-based position) with the result of interpreting the "position" (and the variable 'i') in claims 5 and 10 as a CCE-aggregation-based number. This comparison shows that a CCE-aggregation interpretation is non-sensical. That second (incorrect) scenario would look like:

Illustration 12



150. As shown above, the result of interpreting the "position" of the claims as a CCE-aggregation-based number would cause the L CCEs that make up an 8-CCE aggregation to fail

to be “contiguous” as required by the claims, and instead to be spread across a span of time such that portions of a CCE-aggregation would be spread across multiple subframes. Those results are inconsistent with the rest of the ’332 patent and its claims. One of skill in the art would also know that neither of these results would make sense or be workable in the real world.

151. As also suggested in the above Illustration 12, another way of showing that interpreting the values given by the claims as CCE-aggregation-based numbers would also be non-sensical is by noting that doing so would produce “position” values that would be out of the range of the possible aggregation-based index numbers. For example, for aggregation level L=8, multiplying any resulting Y_k value larger than 0 would result in a “position” of 8 or greater. But there is no CCE-aggregation-based position in the example of Fig. 2 that is any larger than 1. As shown in Figure 2, the only possible values for the CCE-aggregation based index are 0 or 1.

7. Mathematical Expressions 4 and 6 are the *only* expressions disclosed in the specification that use Y_k and a modulo ‘C’ operation, and also give a start position “on a CCE basis rather than on a [CCE-aggregation] basis”

152. Having shown that the Asserted Claims must produce positions on a CCE basis (rather than a CCE-aggregation basis), the only disclosed expressions that produce CCE-based positions are Mathematical Expressions 4 and 6. As background, the ’332 patent provides five[7] “Mathematical Expressions” within four embodiments that the patent states “can be implemented according to…similar principal[s]” to determine “start positions.” *See* ’332 patent at 7:66-8:3. I list each of these expressions below:

Number	**Mathematical Expression**
3	$Z_k = [(A \cdot y_k + B) \bmod D] \bmod C$ $y_0 = x, y_k = (A \cdot y_{k-1} + B) \bmod D$ $k = 0, 1, \ldots, P-1$

[7] The patent describes a total of nine mathematical expressions but makes clear that only expressions 3 through 7 are directed to start positions. *See* ’332 patent at 8:5-10:20.

4	$Z_k = L_{CCE} \cdot [(A \cdot y_k + B) \bmod D] \bmod C$ $y_0 = x, y_k = (A \cdot y_{k-1} + B) \bmod D$ $k = 0, 1, \ldots, P-1$
5	$Z_k = (Y_k \bmod \text{floor}[N_{CCE,k}/L])$ [8] $Y_k = (A \cdot y_{k-1}) \bmod D$
6	$Z_k = L \cdot (Y_k \bmod \text{floor}[N_{CCE,k}/L])$ $Y_k = (A \cdot y_{k-1}) \bmod D$
7	$Z_k = ((A \cdot x_k + B \cdot x_k^2) \bmod D) \bmod C$

153. As shown in the summary of these expressions above, only Mathematical Expressions 4 and 6 compute the start position in terms of CCE-based units, because only those two equations are generated by multiplying 'L' (as highlighted in green) with a number representing an index of a CCE-aggregation. For each of these expressions, this index will always be between 0 and C because of the modulo C operation "mod C" (or similarly, mod floor[$N_{CCE,k}/L$]). I note that in some expressions, C is replaced by $N_{CCE,k}$/L, which the patent says is equivalent to C ('332 patent at 3:22) where "N represents the total number of CCEs in a specific subframe, and L is the number of CCEs that are used to transmit one PDCCH." '332 patent at 3:24-27.

154. Furthermore, the '332 patent confirms that the only two expressions provide values in CCE-based units are expressions 4 and 6. First, for mathematical expression 4 (described in the "second embodiment"), the patent notes that:

> Unlike the first embodiment, the finally obtained search space start position Zk in the subframe corresponding to the index "k" may indicate a corresponding CCE position based on an index assigned to each CCE rather than an index assigned to each CCE aggregation. That is, when the CCE aggregation level is "2", a CCE aggregation index may be assigned on a CCE basis rather than on a 2-CCE basis. Accordingly, this embodiment suggests that a value calculated through the following equation be

[8] For clarity, I have used the explicit operation "floor()" to make clear the operation that is otherwise shown only as bars in the original equation.

> used as a start position of a PDCCH search space under the same condition as in the first embodiment.

’332 patent at 9:17-23.

155. Likewise, the ’332 patent notes that Mathematical Expression 6 is allegedly simply Expression 4 but modified in the sense that “it is assumed that k starts from ‘0’.”

156. Thus, the only formulas that the patent describes as giving CCE-based values are the formulas in Mathematical Expressions 4 and 6. For that reason, one of ordinary skill in the art would understand the term “given by using a variable of Y_k for the subframe k and a modulo ‘C’ operation” to mean “given” by one of those two expressions, namely: “given by one of: $L\cdot[(A\cdot y_k+B) \bmod D] \bmod C$ or $L\cdot(Y_k \bmod C)$” as described at lines 5:30 and 5:58 (with C replacing $N_{CCE,k}/L$).

VI. CONCLUSION

157. For at least the above reasons, the term "wherein Y_k is defined by: $Y_k = (A*Y_{k-1})$ mod D" is indefinite, and the term "given by using a variable of Y_k for the subframe k and a modulo 'C' operation" should be construed to mean "given by one of: $L \cdot [(A \cdot y_k + B) \bmod D] \bmod C$ or $L \cdot (Y_k \bmod C)$."

Date: December 12, 2019

Mark R. Lanning.

EXHIBIT A

Curriculum Vitae

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Mark R. Lanning

Mark is currently the President of Telecom Architects, Inc., I.N. Solutions, Inc.[1] and Reticle Consulting, LLC. Each of these companies provides professional consulting services and custom software development for one or more particular technical areas. I.N. Solutions (Intelligent Networking Solutions) was established in 1991 with an emphasis on applications design and network architecture engineering for telephone-based switching and Advanced Intelligent Networking systems. Telecom Architects was established in 1999 to provide specialized consulting services to fixed and wireless telecom service providers and their equipment suppliers. Reticle Consulting was created in 2009 to provide specialized consulting services for forensic software analysis and software source code comparison for software misappropriation cases.

Mark has over 35 years of engineering experience in all the development life cycle phases for hardware and software products. He has worked with both network operators and product suppliers regarding network architectures and product development and has acquired key insights into their perspectives and requirements as both suppliers and customers.

While working for three different product suppliers, Mark was directly responsible for the design, development and rollout of new products that have earned combined revenues in excess of one billion dollars for their respective companies. These products include: the DSC/Alcatel Signal Transfer Point (STP) product; the Telinq/ADC M13 transmission multiplexer and analyzer products; and the Tandem/HP Service Control Point (SCP), Service Management System (SMS); Service Creation Environment (SCE) products and their applications.

Since starting I.N. Solutions in 1991, Mark has worked with Motorola, Sprint, Nextel, and British Telecom (BT) to roll out some of the most successful telecom applications and network expansions worldwide. Mark was directly involved in the design of Sprint's Common Channel Signaling System 7 (SS7) network and the design and rollout of its FON (calling card) and 800 number services. Mark was the program manager responsible for the design and rollout of BT's Advanced Cellular Network (ACN) that used AIN functionality. BT's ACN was one of the largest cellular networks in the world and also includes advanced corporate virtual private network (VPN) and pre-pay validation services. Starting in 1998, Mark and the Telecom Architects (TAI) team were contracted by Nextel to design their 2.5G cellular iDEN switching, VoIP dispatch network[2] and its TDM/SONET transmission networks. After completion of the 2.5G network design, Mark and the TAI team performed a large part of the qualification, testing and rollout phases for new equipment suppliers and their applicable products into Nextel's network.

Before starting his own consulting company in 1991, Mark was initially employed as individual contributor on both hardware and software development projects, later worked as a manager on hardware and software development groups that varying in size from 5-20 engineers and eventually held several executive management positions with responsibility of over 200 engineers.

Hardware and Software Development Experience

Mark's hardware and software experience began in 1974 while in the US Army Signal Corps. Mark was initially trained as a hardware technician on data and voice crypto (encrypted transmission) communications equipment. After achieving the "top graduate" award at three different hardware and

[1] I.N. Solutions Inc. is no longer active.
[2] Also referred to as the Nextel push-to-talk or walkie-talkie feature that did not require a voice bearer channel.

software training schools, Mark received a Top Secret security clearance and was transferred to the Army Security Agency (ASA). His assignment with the ASA included joint software development with the National Security Agency (NSA) and the white house communications staff. The software development was done on “state of the art” computer and communication systems built by DEC and GE using assembly language.

From 1978-1983, Mark worked as both a hardware and software development engineer for IT&T Defense Communications. The majority of his time was spent on building a new store and forward message switching system that was used by the white house, US embassies worldwide and two major US airlines. DEC PDP-11 and PDP-15 computers were coupled together and operated in conjunction with custom IT&T hardware for this system. The system architecture was traditional mini-computer architecture with sixteen front-end communications computers to interface with hundreds of modems and perform various communications protocols. The software was written in DEC assembly language. Many different types of communications protocols and state of the art modems were used with this system.

In 1983, Mark was hired as hardware and software development engineer by Digital Switch Corporation (now a part of Alcatel) and was later promoted to design and development manager responsible for their initial SS7 protocol and Signal Transfer Point (STP) products. The STP product performed packet switching for thousands of messages per second between telephone switches for the purpose of connecting normal phone calls worldwide and support of advanced telephony services. The STP was designed to have a fault tolerant hardware and software architecture to provide 24x7 operation and provided interfaces to various telephone company management and support systems. A typical configuration of the STP product included at least 200 separate microprocessor boards working in a closely coupled distributed system architecture. Communications between the processors was performed over parallel hardware buses using DSC’s proprietary operating system. Mark was also responsible for development of all the communication protocols the STP would require to communicate with other switching, operations and administration systems. These protocols were X.25, X.75, SS7 MTP/SCCP/TCAP and FTP. The hardware used was Zilog Z-8000 and Motorola 68xxx family microprocessors. The software was written in assembly and C languages.

In 1985, Mark was hired by Telinq Inc. (now part of ADC) as their director of software development and was later promoted to vice president of hardware and software development. Telinq was a venture capital start-up company and their initial two products were high speed digital TDM transmission multiplexers and analyzers mainly used by telecom network operators and service providers. The hardware consisted of multiple Motorola 68xxx family processors replicated different types of custom designed high-speed gate arrays. The software was distributed and written in C and assembly language.

In 1987, Mark joined the Telecom Division of Tandem Computers, Inc. (now part of HP) as their Vice President of hardware and software development. Tandem Telecom was a new division that built products for telephone companies that leveraged its fault tolerant Guardian and Unix based computer systems. The initial products built under Mark’s direction were a Service Control Point (SCP), Service Management System (SMS) and Service Creation Environment (SCE). Although these product names are unique to Intelligent Networking telephony systems, they use state of the art hardware and software to perform many standard functions. The SCP system performs on-line transaction processing for the telephone switches in a network. These transactions support phone company services like 800 number translation, calling card number validation and home location register (HLR) functionality for cellular networks. The SCP was a fault tolerant multiple processor system capable of supporting hundreds of globally located nodes with multiple processors in each node. Each SCP required specialized

communications software and hardware that was build by Tandem Telecom. The full suite of commercial communications software was supported including X.25, TCP/IP and SS7. The software was written in C, C++ and assembly language. The SMS system was build to manage multiple SCP systems, update the software applications and keep their multi-million record databases synchronized. The SMS software was written in C and C++. The SCE was telephone service authoring tool used by telephone company personnel to modify or create new services on their network without requiring them to be intimately familiar with the underlying system or detailed programming. The SCE software ran on Unix or PC Windows operating systems and was written in C++ and C and the most advanced software development workbench software.

Program and Project Management Experience

Mark has been directly involved with formal project management concepts and tools since 1984. Most, if not all, the projects listed above were managed using project management concepts and tools. The main techniques used for these projects were PERT and CPM. Mark either generated the initial PERT chart and staff assignments for each project or was directly involved in defining the program logic and assignments to be used. Since 1984, every project that Mark has been responsible for has included formal product life cycle documentation, requirements tracking, problem reporting and resolution.

Since 1991, Mark has been responsible for some large development and network architecture projects with a budget in excess of $100 million each. Two of these projects were for British Telecom's cellular network division called Cellnet. The initial project, ACN, was an on-line transaction processing (OLTP) system responsible for real-time dialed digit translation for every phone call in the Cellnet network and was required to perform thousands of transactions per second. The second project replaced Cellnet's batch-oriented billing system with a distributed real-time call detail record collection and on-demand rating and billing system. Both of these systems required custom development for a majority of the software that was done by different companies located across multiple countries and continents. The ACN project lasted about four years and involved over 100 software development personnel located in Texas, Nebraska, California, Sweden, Spain, Finland and England. The billing system project lasted more than three years and required over 600 developers at its peak that were located in England, Colorado, Texas and Sweden. Both of these systems were 24x7 mission critical to completing wireless calls and billing.

Mark and members of the Telecom Architects group have developed innovative methods for requirements definition, design, modeling and documentation of large telecommunications networks. Some of this methodology has been published by Wireless Review Magazine.

In 1977 and 1978 Mark obtained a Private Pilot, Commercial, Instrument, and Flight Instructor ratings.

Mark received a BS in Computer Science degree from Southern Methodist University in 1983 and has been a visiting lecturer at SMU on various data and voice telecommunications subjects.

Industry Memberships

Member of IEEE and IEEE Standards Association.
Member of ACM (Association for Computing Machinery).

Telecom Standards Definition

Mark is one of the Advanced Intelligent Network (AIN) and Signaling System Number 7 (SS7) pioneers. He was a contributing member of the first ANSI T1X1 standards group that defined and approved the initial North American AIN and SS7 requirements and was actively involved with this group for three years. These standards were later adopted by the ITU.

Telephony Systems

Mark has been directly involved with the development and/or detailed functional analysis of the following systems: DSC/Alcatel DEX-STP, DEX-400, DEX-600 and MegaHub circuit switches; Nortel DMS circuit switch for class IV and MSC applications; Ericsson AXE circuit switch for class IV, MSC and HLR applications; Lucent's 5ESS circuit switch in class IV, class V and MSC applications; Tandem/HP SCP, SMS, SCE and HLR.

Mark has also been intimately involved with the design, analysis and/or network implementation of many different PSTN and cellular network elements including at least: MSC, VLR, HLR, BSC, BTS, SMSC, MMSC, GGSN/SGSN, eNodeB, and RNC.

Network Design Experience Summary

Mark has extensive telecommunications network design experience for both North American and European fixed and wireless networks. He has participated in the creation of RFIs and RFPs and the evaluation of supplier responses; negotiated supplier equipment contracts; written requirements for custom hardware and software features and has led engineering teams in the design and rollout of new networks and network expansions. These network designs included LANs, WLANs, WANs, TDM and SONET transmission networks, signaling system 7 (SS7) networks, ATM/IP data switching/routing, mission critical on-line transaction processing enterprise networks and voice switching networks using traditional circuit switches, soft switches and media gateways.

Software Development Languages and Tools

Assembly language for DEC PDP-11, PDP-15, Zilog Z-80 & Z-8000, and Motorola 68xxx processors.
Fortran IV and Fortran 77.
Cobol.
Pascal.
Basic and Visual Basic
C and C++
X Windows, Motif and SmallTalk Toolkits
Microsoft Office FrontPage
Java and JavaScript

Publications

Mark Lanning and David Sanders, "In Sync" Wireless Review. January 15, 2000.

Technical Expert Experience for Cases Filed Since 2014.01.01

Intellectual Ventures I LLC v. United States Cellular Corporation, C. A. No. 1:13-cv-1672-LPS; Intellectual Ventures II LLC v. United States Cellular Corporation, C. A. No. 1:14-cv-1233-LPS; Intellectual Ventures I LLC v. AT&T Mobility LLC et al., C. A. No. 1:13-cv-01668-LPS; Intellectual Ventures II LLC v. AT&T Mobility LLC et al., C. A. No. 1:14-cv-1229-LPS; Intellectual Ventures I LLC v. Cricket Communications, Inc., C. A. No. 1:13-cv-1669-LPS; Intellectual Ventures II LLC v. Cricket Communications, Inc., C. A. No. 1:14-cv-1230-LPS; Intellectual Ventures I LLC v. Nextel Operations, Inc. and Sprint Spectrum L.P., C. A. No. 1:13-cv-1670-LPS; Intellectual Ventures II LLC v. Nextel Operations, Inc. and Sprint Spectrum L.P., C. A. No. 1:14-cv-1231-LPS; Intellectual Ventures I LLC v. T-Mobile USA, Inc. and T-Mobile US, Inc., C. A. No. 13-cv-1671-LPS; Intellectual Ventures II LLC v. T-Mobile USA, Inc. and T-Mobile. All cases are before the United States District Court for the District of Delaware. Patent Infringement cases regarding cellular networks and/or devices. On behalf of Ericsson.

InterDigital Communications Corporation v. Huawei Technologies Co. Ltd. Arbitration before the International Court of Arbitration. Patent licensing and analysis of ETSI Standard Essential Patents for UMTS and LTE. On behalf of Huawei. Provided testimony at deposition and hearing.

Inter Partes Reviews for Intellectual Ventures LLC's U.S. Patent Nos. 8,310,993; 7,385,994; 6,640,248; and 6,023,783. On behalf of Ericsson. Provided deposition testimony.

Genband U.S. LLC v. Metaswitch Networks Ltd and Countersuit. C.A. No. 2:14-CV-33, 2:14-CV-744 and 2:16-cv-582. Before the United States District Court for the Eastern District of Texas in Marshall. Patent infringement case regarding Internet and switching devices. On behalf of Genband. Provided testimony for multiple depositions and multiple trials.

Atlas IP, LLC v. Medtronic, Inc., et al. C.A. No. 12-23309-CIV. Before the United States District Court for the Southern District of Florida. Patent Infringement case regarding MAC communications and medical devices. On behalf of Medtronic. Provided deposition testimony.

Intellectual Ventures I LLC and Intellectual Ventures II LLC v. Capital One. C.A. No. 8:14-cv-00111. Before the United States District Court for the District of Maryland. Patent Infringement case regarding banking applications on cellular devices. On behalf of Capital One.

Comcast Cable Communications LLC, et al. v. Sprint Communications Company L.P., et al. C.A. No. 2:12-cv-0859. Before the United States District Court for the Eastern District of Pennsylvania. Patent infringement case regarding cellular networks and/or devices. On behalf of Sprint. Provided deposition and trial testimony.

LM Ericsson, et al. v. Wi-LAN USA, Inc. et al., C.A. No. 1:14-21854. Before the United States District Court for the Southern District of Florida. Contract dispute regarding cellular network equipment licensing. On behalf of Ericsson.

Intellectual Ventures I LLC et al. v. AT&T Mobility LLC et al. C.A. No. 12-cv-193 (Filed 2/16/2012). Before the United States District Court for the District of Delaware. Patent infringement case regarding cellular messaging. On behalf of AT&T Mobility, Sprint, T-Mobile, and U.S. Cellular. Provided deposition testimony.

OptumSoft, Inc. v. Arista Networks, Inc., C.A. No. 114CV263257. Before the Superior Court of California, County of Santa Clara. Contract dispute regarding ownership of software for telecommunications equipment. On behalf of Arista Networks, Inc. Provided deposition and trial testimony.

Transverse, LLC v. Info Directions, Inc. d/b/a IDI Billing Solutions. In the Iowa District Court for Polk County. Trade secret misappropriation case regarding cellular billing software. On behalf of Transverse. Provided testimony for multiple depositions.

KPN N.V. v. Samsung Electronics America, Inc. et al. C.A. No. 2:14-cv-1165. Before the United States District Court for the Eastern District of Texas, Marshall Division. Patent infringement case regarding cellular devices. On behalf of Samsung.

Core Wireless v. LG Electronics, Inc. and LG Electronics MobileComm U.S.A., Inc., C.A. No. 2:14-cv-911 (lead case) and C.A. No. 2:14-cv-912 (consolidated). Before the United States District Court for the Eastern District of Texas, Marshall Division. Patent infringement case regarding cellular networks and/or devices. On behalf of LG. Provided deposition and trial testimony.

Wireless Protocol Innovations v. TCT Mobile (US) Inc. et al. C.A. No. 6:15-cv-00918. Before the United States District Court for the Eastern District of Texas, Tyler Division. On behalf of TCT Mobile. Provided deposition testimony.

Cellular Communications Equipment LLC (Acacia) v. T-Mobile USA, Inc. et al. C.A. No. 2:15-cv-00576, 2:15-cv-00579, 2:15-cv-00580, and 2:15-cv-00581. Before the United States District Court for the Eastern District of Texas, Marshall Division. On behalf of Ericsson.

Huawei Technologies Co. Ltd. v. T-Mobile USA Inc., Nokia Solutions and Networks, et al. C.A. Nos. 2:16-cv-00052 and 2:16-cv-00056. Before the United States District Court for the Eastern District of Texas, Marshall Division. On behalf of Nokia & Cisco. Provided deposition testimony.

Nokia Solutions and Networks US LLC, et al. v. Huawei Technologies Co. LTD., et al. C.A. Nos. 2:16-CV-00753, 754, 755 and 756. Before the United States District Court for the Eastern District of Texas, Marshall Division. On behalf of Nokia.

Sycamore IP Holdings LLC v. AT&T Inc. et al. C.A. No. 2:16-cv-00588. Before the United States District Court for the Eastern District of Texas, Marshall Division. On behalf of AT&T. Provided deposition testimony.

Apple Inc. v. Wi-LAN Inc. C.A. No. 3:14-cv-02235 and Wi-LAN Inc. v Apple Inc. C.A. No. 3:14-cv-01507 (Filed June 2014). Before the United States District Court for the Southern District of California in San Diego. On behalf of Apple. Provided deposition and trial testimony.

Bascom Global Internet Services Inc. v. AT&T Inc. C.A. No. 3:14−cv−03942. Before the United States District Court for the Northern District of Texas in Dallas. On behalf of AT&T.

Apple Inc. v. Qualcomm Inc. C.A. No. 3:17-cv-00108. Before the United States District Court for the Southern District of California in San Diego. On behalf of Apple.

Koninklijke KPN NV. v. TCL Corporation et al. C.A. No. 1:17-cv-00091. Before the United States District Court for the District of Delaware. On behalf of TCL.

Blackberry Limited, et al. v. Avaya Inc. C.A. No. 3:16-cv-2185. Before the United States District Court for the Northern District of Texas in Dallas. On behalf of Avaya.

Plectrum LLC v. AT&T Mobility LLC. C.A. No. 4:17-cv-120. Before the United States District Court for the Eastern District of Texas in Sherman. On behalf of AT&T.

Securus Technologies Inc. v. Global Tel*Link Corporation. C.A. No. 3:16-cv-01338. Before the United States District Court for the Northern District of Texas in Dallas. On behalf of Securus.

Intellectual Ventures I, LLC and Intellectual Ventures II, LLC v. Ericsson. C.A. No. 1:14-cv-01233-LPS. Before the United States District Court for the District of Delaware. On behalf of Ericsson.

Iridescent Networks, Inc. v. AT&T Mobility LLC and Ericsson Inc., C.A. No. 6:16-cv-1003-RWS-JDL. Before the United States District Court for the Eastern District of Texas in Tyler. On behalf of AT&T. No worked performed as of 10/01/2019.

Network Managing Solutions, LLC v. AT&T Mobility, LLC. C.A. No. 1:16-cv-00295−RGA (Filed April 2016). Before the United States District Court for the District of Delaware. On behalf of AT&T Mobility. No worked performed as of 10/01/2019.

Barkan Wireless IP Holdings, L.P. v. Samsung and Verizon. C.A. No. 2:18-cv-28-JRG. Before the United States District Court for the Eastern District of Texas, Marshall Division. On behalf of Samsung and Verizon.

Genband U.S. LLC and Sonus Networks, Inc. v. Metaswitch Networks Ltd and Countersuit. Cause No. DC-17-03697. Before the District Court of Dallas County, Texas, 134th Judicial District. Case regarding Internet and switching devices. On behalf of Genband.

Maxell, Ltd. v. Huawei Technologies Co. Ltd. et al. C.A. No. 5:16-cv-00178−RWS (Filed Nov. 2016). Before the United States District Court for the Eastern District of Texas, Texarkana Division. On behalf of Huawei. Inter Partes Review of U.S. Pat. Nos. 6,973,334, 6,983,140, and 7,324,487.

Zest Labs Inc et al v. Wal−Mart Inc. C.A. No. 4:18−cv−00500−JM (Filed Aug. 2018). Before the United States District Court for the Eastern District of Arkansas, Little Rock Division. On behalf of Zest. Case active as of 10/01/2019.

Zomm, LLC v. Apple Inc. C.A. No. 4:18-cv-04969−HSG (Filed Apr. 2018). Before the Before the United States District Court for the Northern District of California, Oakland Division. On behalf of Apple. Inter Partes Review of U.S. Pat. No. 8,351,895. Case active as of 10/01/2019.

Sol IP, LLC, v. AT&T Mobility LLC. C.A. No. 2:18-cv-526-RWS-RSP (Filed 2018). Before the United States District Court for the Eastern District of Texas, Marshall Division. On behalf of AT&T. Case active as of 10/01/2019.

Packet Intelligence LLC v Nokia Solutions and Networks U.S. LLC. C.A. No. 2:18-cv-00382-JRG (Filed Aug. 2018). Before the United States District Court for the Eastern District of Texas, Marshall Division. On behalf of Nokia.

Carucel Investments L.P. v. General Motors Company, et. al. C.A. No. 3:18−cv−03332 (Filed Dec. 2018). Before the Before the United States District Court for the Northern District of Texas, Dallas Division. On behalf of Carucel. Case active as of 10/01/2019.

Rembrandt Wireless Technologies, L.P. v Apple Inc. C.A. 2:19-cv-00025-JRG (Filed Jan. 2019). Before the United States District Court for the Eastern District of Texas, Marshall Division. On behalf of Apple. Inter Partes Review of U.S. Pat. Nos. 8,023,580 and 8,457,228. Case active as of 10/01/2019.